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PROPERTIES OF INORGANIC SUBSTANCES

A SECOND REVISION AND ENLARGEMENT
OF TABLES OF PROPERTIES OF OVER
FIFTEEN HUNDRED COMMON
INORGANIC SUBSTANCES

BY

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BOOK DEPARTMENT

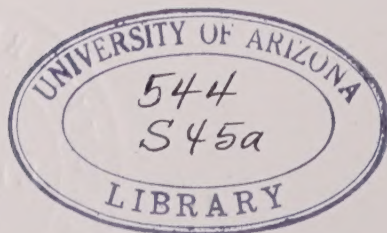
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To

A. M. S.

*without whose help
this work had not been completed
this little book is
affectionately and gratefully
dedicated*

PREFACE

This book was originally published in 1909 under the title *Tables of Properties of over fifteen hundred common inorganic substances*. It was so favorably received that a second edition embodying minor changes made to bring the book to date was published in 1916.

The recent appearance of International Critical Tables and other valuable reference books on chemistry has made possible, first a thoroughgoing revision in order to include all the latest numerical data available, and second a considerable enlargement of the text by the inclusion of much new additional descriptive matter on substances treated in the earlier editions and by the addition of an equally full treatment of about seven hundred and fifty compounds not before included.

New compounds include, among others, the carbides, hydrides, and hypochlorites of the members of the six groups of bases, and the bromides, carbonates, chlorides, hydroxides, nitrates, sulfates, and sulfides of the non-metals and rare metals.

The common and trade names were very fully given in the earlier editions. They have, however, been considerably increased by a careful selection of about six hundred new names from sources recently published.

The properties of substances have been amplified so far as possible by the addition, under the solubility in water, of the number of grams of the substance soluble in one hundred grams of water at 0°C, at ordinary temperature and at 100°. In the solubility data the decimals in the numerical value have usually for convenience been omitted.

Much other material of a miscellaneous character obtained from recent publications has been included, notably the melting points and specific gravities of many compounds.

The nomenclature and the abbreviations have been made to conform to those used by the American Chemical Society in its publications,—a convention which tends towards uniformity in our chemical literature and which lessens the labor of chemists using the same.

The arrangement of the text has not been materially altered. For a description of this and for directions for finding desired information the reader is referred to the accompanying *Preface to the First Edition*.

The index has been revised to include all new material added to the text.

In addition to the authorities previously acknowledged, the author takes pleasure in inscribing his indebtedness in connection with the present edition to the following: International Critical Tables, Comey and Hahn's Dictionary of Chemical Solubilities, Seidell's Solubilities of Inorganic and Organic Substances, Mellor's Comprehensive Treatise on Inorganic and Theoretical Chemistry, Roscoe and Schorlemmer's Treatise on Chemistry, Molinari's General and Industrial Chemistry, Gmelin-Kraut's Handbuch der Anorganischen Chemie, the Condensed Chemical Dictionary, Hopkins' Chemistry of the Rarer Elements, the Chemists' Year Book, Gardner's Chemical Synonyms and Trade Names, Evans' Metals and Metallic Compounds, and numerous other smaller works.

A sincere attempt has been made to make this little work of reference as complete, reliable and up-to-date as possible. If any users find any errors or omissions they will confer a favor by communicating such to the author.

W. S.

EXETER, N. H., 1926.

PREFACE TO THE FIRST EDITION

When the author was studying Qualitative Analysis in college he felt the great need of a complete list of inorganic substances, giving such properties as would enable him to corroborate the results given by the tests in salt analysis. Looking up the desired information in the larger reference books consumed much time and was often unsatisfactory. During several years' teaching of the subject he has felt the need of such a work more and more; therefore, about five years ago he compiled a temporary manuscript list of about six hundred salts and laid it out for the general use of the class in Qualitative Analysis. The copy was used considerably by the students,—simply to corroborate the tests, never to replace the actual systematic testing at the laboratory desk. The results were so satisfactory that he decided to revise and enlarge the list, particularly as it was early seen that all chemists would find it a helpful reference work; hence the appearance of this little book.

The tables on the following pages give the principal properties of such substances as may reasonably be looked for in a course in Qualitative Analysis. No attempt is made to record every known salt of every metal. Consequently, only the metals of the six groups usually studied are included, together with their oxides, hydroxides and more common salts. To increase the value of the book for general reference, tables are added covering the acids, non-metals and rare metals.

The grouping of the metals used in these pages is that employed by Fresenius, viz.,

Group	I	Na, K, Li, NH ₄
Group	II	Ba, Sr, Ca, Mg
Group	III	Al, Cr
Group	IV	Fe, Co, Ni, Mn, Zn
Group	V	Ag, Pb, Hg, Cu, Cd, Bi
Group	VI	As, Sb, Sn

The following substances are included under each group of bases.

1. The metal	13. Ferrocyanide	25. Oxide
2. Acetate	14. Ferricyanide	26. Phosphate
3. Arsenate	15. Fluoride	27. Phosphite
4. Arsenite	16. Hydroxide	28. Silicate
5. Borate	17. Hypophosphite	29. Silicofluoride
6. Bromate	18. Iodate	30. Sulfate
7. Bromide	19. Iodide	31. Sulfide
8. Carbonate	20. Manganate	32. Sulfite
9. Chlorate	21. Molybdate	33. Tartrate
10. Chloride	22. Nitrate	34. Thiocyanate
11. Chromate	23. Nitrite	35. Thiosulfate
12. Cyanide	24. Oxalate	36. Tungstate

The properties given include state, color, luster, crystalline form, deliquescence, efflorescence, stability in air, action on test paper, melting point, behavior when heated, solubility in water, alcohol and acids, and any other properties that are characteristic of the substance in hand. For convenience, the formulas, the chemical names and the common names are all given.

To find the properties of a salt look first in the upper outside corner of the page for the group to which the metal in the salt belongs. Under each group the metals come first, and then the salts are arranged in alphabetical order, the name of the acid radical being placed in small heavy-faced type in the outside margin of each page. Opposite these marginal names will be found the formulas and names of the corresponding salts of the several members of the group. Acid salts and basic salts are put directly after the normal salts. Hence, to find *acid sodium sulfate*, find **Sulfate** in the margin under the **Na, K, Li, NH₄ Group**, and in the compartment opposite **Sulfate**, and under **Sodium**, will be found, first Na_2SO_4 , and then NaHSO_4 .

Double salts are put with the normal salt of the more prominent metal in the double salt; hence, to find *nickel-ammonium sulfate*, find **Sulfate** in the margin under the **Al, Cr, Fe, Co, Ni, Mn, Zn Group**, and in the compartment opposite **Sulfate**, and under **Nickel** will be found, first NiSO_4 , and then $\text{Ni}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$. A cross reference is usually put in the proper place under the less important metal of the double salt.

In the case of iron, mercury and copper, separate columns contain the *ous* and the *ic* compounds. In the few other cases where *ous* and *ic* compounds exist, both will be found in the same compartment. With the exception of iron, mercury and copper, each metal that forms more than one oxide has all the oxides in the compartment opposite the marginal heading **Oxide**. For ease in classification, acid anhydrides are considered as oxides of the metal. Since dichromates and permanganates are few in number, they are put with the chromates and manganates respectively.

For much of the material in these pages the author is indebted to such standard works of reference as Watts' Dictionary of Chemistry, Dammer's Handbuch der Anorganischen Chemie, Comey's Dictionary of Chemical Solubilities, and the Chemiker-Kalender. For the arrangement of the material the author himself is responsible, and perhaps he will be pardoned for saying that he considers the separation into the six groups of bases better than arranging all the salts in one alphabetical list, or grouping all the salts of each acid together. With the arrangement used in these pages it is possible, not only to find all the salts of any one metal together, but also to compare any salt of the metal in question with the corresponding salt of each of the other members of the group to which the metal in question belongs. With very little trouble it is possible to compare the salts of any one group with the corresponding salts in the other five groups.

Atomic weights are taken from the Report of the International Committee on Atomic Weights for 1909 as published in the *Journal of the American Chemical Society* for January, 1909; other numerical data are taken from the most reliable sources obtainable. All temperatures are recorded in centigrade degrees.

The page numbers are put at the bottom of the pages because they are of little use in reference. The quickest way is to look up, as has been described, first the group at the top of the page and then the name of the salt in the margin.

The section on acids is valuable not only on account of the description of the free acid, but also for the condensed statements relating to the salts of each acid. The section on non-metals and rare metals treats of such substances as do not fit into the tables of the six regular groups of bases. The index at the end of the book will be found useful in finding a salt when only its common name is known. Any corrections or suggestions will be most gratefully received.

W. S.

EXETER, N. H., 1909.

PREFACE TO THE SECOND EDITION

The plan and scope of the second edition follows closely that of the first edition. The atomic weights have been revised to correspond with the Report of the International Committee on Atomic weights for 1916. Other minor changes have been made to bring the book to date.

W. S.

EXETER, N. H., 1916.

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ABBREVIATIONS

abs.	= absolute.
amorph.	= amorphous.
Aq.	= water of solution or dilution.
aq.	= aqueous.
At. No.	= atomic number.
At. Wt.	= atomic weight.
B. P.	= boiling point.
c.	= about.
compn.	= composition.
concd.	= concentrated.
cryst.	= crystals, crystalline, crystallizes.
decomp.	= decomposes, decomposed, decomposition.
deliq.	= deliquescent, deliquesces.
dil.	= dilute.
efflor.	= efflorescent, effloresces.
g.	= gram, grams.
insol.	= insoluble.
M'	= a univalent metal.
M''	= a bivalent metal.
Mol. Wt.	= molecular weight.
M. P.	= melting point.
ppt.	= precipitate.
pptd.	= precipitated.
ppts.	= precipitates.
q. v.	= which see.
repptd.	= reprecipitated.
reppts.	= reprecipitates.
sl.	= slightly, slight.
sp. gr.	= specific gravity.
sol.	= soluble.
soln.	= solution.
solns.	= solutions.
t°	= temperature in centigrade degrees.
temp.	= temperature.
v.	= see.
val.	= valence.

GROUP I

Sodium	Na
Potassium	K
Lithium	Li
Ammonium	NH ₄

The three metals of this group are univalent, grayish, very soft, and lighter than water, which they decompose at ordinary temperature, with evolution of hydrogen and formation of strongly alkaline-reacting hydroxides; for this reason they are often spoken of as the alkali metals. The radical NH₄ is not known in the free state. The pure oxides (M'₂O) are difficult to prepare, cautious heating of the metal in the air forming peroxides (M'₂O₂) at the same time. The salts of these metals, as well as of ammonium, are generally colorless crystals or white powders; they are all soluble in water, except Li₂CO₃, Li₂HPO₄, and Na₂H₂Sb₂O₇, which are very sparingly soluble. Many salts of Na and K are volatile at high heat; all NH₄ salts volatilize,—some of them with decomposition. Li salts color the Bunsen flame red, Na yellow, and K violet. Alkaline reaction is imparted to test paper by aqueous solutions of the carbonates, the secondary and the tertiary phosphates, the cyanides and the borates.

Na, K, Li, NH₄ GROUP

Metal

	Sodium	Potassium	Lithium	Ammonium
	Na, <i>sodium, natrium</i>. Light, soft, malleable, ductile metal; occasionally lustrous, white, quadratic octahedra; silver-white and very lustrous when freshly cut, but oxidizes easily on exposure to air, becoming dull gray; evolves H₂ rapidly from cold water, leaving NaOH in solution, but the H₂ generally does not catch fire; burns in air with a yellow flame, the oxide formed being a mixture of Na₂O and Na₂O₂; must be kept in air-tight cans or under a liquid, free from O₂, such as naphtha; fairly hard at -20°, ductile at 0°, soft as wax at ordinary temp., pasty at c. 50°, melts at 97.5°, and boils at c. 880°; vapor is colorless or violet; sol. in liquid NH₃; decomp. alcohol violently; insol. in hydrocarbons; reacts violently with acids, forming sol. salts; the metal may be heated to melting or even higher temp. without catching fire; combines with the halogens when heated; all Na salts color the Bunsen flame yellow; Na is sometimes obtainable as small cryst. At. No. 11; At. Wt. 22.997; Mol. Wt. probably the same; val. 1; sp. gr. 0.97; M. P. 97.5°; B. P. 880°; 1 isotope.	K, <i>potassium, kalium</i>. Light, soft, malleable, ductile metal; occasionally quadratic octahedra; bluish white and highly lustrous on freshly cut surface, but oxidizes easily and rapidly on exposure to air, becoming dull, bluish gray; evolves H₂ rapidly from cold water, leaving KOH in solution, enough heat being generated to set fire to the H₂, which burns with a violet flame; the metal itself burns with an intense violet light, the oxide left being a mixture of K₂O and K₂O₂; must be kept in air-tight cans, or under a liquid free from O₂, such as naphtha; brittle at 0°, soft as wax at ordinary temp., and melts easily at c. 62.3°, or when pressed between the fingers; vapor is green; sol. in liquid NH₃; decomp. alcohol violently; insol. in hydrocarbons; reacts violently with acids forming sol. salts; the metal combines with the halogens when heated; K salts generally color the Bunsen flame violet; the metal is sometimes obtainable as small cryst. At. No. 19; At. Wt. 39.095; Mol. Wt. probably the same; val. 1; sp. gr. 0.86; M. P. 62.3°; B. P. 760°; 2 isotopes.	Li, <i>lithium</i>. Silver-white, somewhat ductile, not very tenacious metal; it is the lightest known metal, being less than two-thirds as heavy as water; very soft, but harder than Na or K; has yellowish tinge when freshly cut; oxidizes readily on exposure to air; evolves H₂ from cold water, leaving LiOH in solution, but the H₂ does not catch fire, nor does the metal melt as Na does; when heated in air it burns with an intense, white light, forming Li₂O; the metal does not vaporize at red heat; sol. in liquid NH₃; insol. in hydrocarbons; reacts easily with acids, forming sol. salts; in HNO₃ Li often melts and ignites; combines with the halogens when heated; all Li salts color the Bunsen flame red. At. No. 3; At. Wt. 6.939; Mol. Wt. probably the same; val. 1; sp. gr. 0.53; M. P. 186°; M. P. 1200°; 2 isotopes.	NH₄, <i>ammonium</i>. A radical that acts like an atom of a univalent metal; it has never been isolated, and is known only in combination with acid radicals in ammonium salts, which give no flame coloration.
Acetate	NaC₂H₃O₂·3H₂O, <i>sodium acetate</i>. Colorless, monoclinic cryst.; efflor. on exposure;	KC₂H₃O₂, <i>potassium acetate</i>. White, very deliq., cryst. powder, or scaly masses with	LiC₂H₃O₂·2H₂O, <i>lithium acetate</i>. Colorless, rhombic prisms; extremely sol. in water; sol.	NH₄C₂H₃O₂, <i>ammonium acetate</i>. Large, odorless, deliq. needles; cryst. with difficulty; de-

Sodium	Potassium	Lithium	Ammonium	Acetate <i>Cont.</i>
sol. in water, approximately 34 g. of the anhydrous salt in 100 g. of water at 0°, 49 g. at 20°, 65 g. at 40°; sp. gr. 1.45; M. P. 58°.	satinny luster; saline taste; extremely sol. in water, 188 g. in 100 g. of water at 5°, 229 g. at 14°, 492 g. at 62°; cryst. with difficulty; sol. in alcohol; insol. in ether; sp. gr. 1.8; M. P. 292°.	in alcohol; M. P. 70°.	comp. when its soln. is evaporated; extremely sol. in water.	
$\text{NaH}(\text{C}_2\text{H}_3\text{O}_2)_2$, acid sodium acetate. Cubic cryst.; sol. in water.	$\text{KH}(\text{C}_2\text{H}_3\text{O}_2)_2$, acid potassium acetate. Very deliq. needles, laminae or long flattened prisms; decomp. when heated; sol. in water; M. P. 142°.	$\text{LiH}(\text{C}_2\text{H}_3\text{O}_2)_2$, acid lithium acetate. Sol. in water.	$\text{NH}_4\text{H}(\text{C}_2\text{H}_3\text{O}_2)_2$, acid ammonium acetate. Cryst. powder; sol. in water.	
$\text{Na}_2\text{AsO}_4 \cdot 12\text{H}_2\text{O}$, sodium arsenate, normal sodium arsenate, trisodium arsenate, sodium arsenate. White powder; permanent in dry air; alkaline reaction; sol. in water, 21 g. in 100 g. of soln. at 17°; sp. gr. 1.7; M. P. 863°.	K_3AsO_4 , potassium arsenate, normal potassium arsenate, tripotassium arsenate, potassium arsenate. Colorless, deliq. cryst.; sol. in water.	$2\text{Li}_2\text{AsO}_4 \cdot \text{H}_2\text{O}$, lithium arsenate, normal lithium arsenate, trilithium arsenate, lithium arsenate. White powder; sparingly sol. in water; sol. in dil. acids and in $\text{HC}_2\text{H}_3\text{O}_2 + \text{Aq.}$	$(\text{NH}_4)_3\text{AsO}_4 \cdot 3\text{H}_2\text{O}$, ammonium arsenate, normal ammonium arsenate, triammonium arsenate, ammonium arsenate. White, efflor. cryst.; sol. in water with difficulty.	Arsenate
$\text{Na}_2\text{HAsO}_4 \cdot 12\text{H}_2\text{O}$, acid sodium arsenate, disodium arsenate, dung salt. Large, clear, colorless, monoclinic prisms; mild, alkaline taste; sol. in water, 17 g. in 100 g. of water at 0°, 56 g. at 14°; insol. in alcohol; efflor. quickly, leaving $\text{Na}_2\text{HAsO}_4 \cdot 7\text{H}_2\text{O}$; sp. gr. 1.7; M. P. 28°.	KHAsO_4 , acid potassium arsenate, dipotassium arsenate, Macquer's salt. White powder; sol. in water.	Unknown.	$(\text{NH}_4)_2\text{HAsO}_4$, acid ammonium arsenate, diammonium arsenate. Quadratic prisms; efflor., giving off NH_3 ; more sol. in water than the normal arsenate.	
$\text{NaH}_2\text{AsO}_4 \cdot \text{H}_2\text{O}$, acid sodium arsenate, monosodium arsenate. White powder; more sol. in water than the other two Na arsenates; sp. gr. 2.5.	KH_2AsO_4 , acid potassium arsenate, monopotassium arsenate. Stable, octahedral cryst.; sol. in water, 19 g. in 100 g. of water at 6°; soln. has acid reaction; insol. in alcohol.	$2\text{LiH}_2\text{AsO}_4 \cdot 3\text{H}_2\text{O}$, acid lithium arsenate, monolithium arsenate. Rhombic prisms; sol. in water.	$\text{NH}_4\text{H}_2\text{AsO}_4$, acid ammonium arsenate, monoammonium arsenate. Not efflor.; very sol. in water.	
$\text{Na}_4\text{MgAsO}_6 \cdot v$, Mg arsenate.				
$\text{NaAsO}_2(?)$, sodium arsenite. Never obtained pure; grayish white powder; absorbs CO_2 ; sol. in water.	$\text{KAsO}_2 \cdot \text{H}_2\text{AsO}_3$, acid potassium arsenite. White powder; sol. in water; insol. in alcohol.	Unknown.	NH_4AsO_2 , ammonium arsenite. White powder or lustrous prisms; very sol. in water.	Arsenite

Borate

Sodium	Potassium	Lithium	Ammonium
Na₂B₂O₄·4H₂O, <i>sodium metaborate</i>. Large, monoclinic prisms; sl. efflor.; sol. in water; melts at 57°. Na₂B₄O₇·10H₂O, <i>sodium tetraborate, sodium pyroborate, boraz</i>. Large, hard, monoclinic prisms; sometimes whitish, sometimes clear and colorless; sl. efflor.; loses all its cryst. water when heated; sol. in water, 1 g. in 100 g. of water at 5°, 4 g. at 30°, 52 g. at 100°; soln. absorbs some CO₂ from the air on standing; insol. in alcohol; sweet, cooling taste; M. P. 75°; sp. gr. 1.7. Na₂B₄O₇, <i>anhydrous sodium borate, sodium borate, borax, burnt borax, tincal, tincal, borax glass, nitrified borax, calcined borax</i>. Fine, white, amorph. powder or masses; sweetish, alkaline taste; alkaline reaction; sol. in water; melts at red heat to glass-like mass that dissolves many metallic oxides and salts, forming fusible double salts that are often colored.	K₂B₂O₄, <i>potassium metaborate</i>. Monoclinic cryst.; sol. in water; caustic, alkaline taste. K₂B₄O₇·5H₂O, <i>potassium borate, potassium tetraborate, potassium pyroborate</i>. White powder; alkaline taste; very sol. in water. K₂B₄O₇, <i>anhydrous potassium tetraborate</i>. Very sol. in water.	Unknown. Li₂B₄O₇·5H₂O, <i>lithium borate, lithium tetraborate, lithium pyroborate</i>. White cryst. powder; sol. in water; insol. in alcohol. Li₂B₄O₇, <i>anhydrous lithium tetraborate</i>. Deliq.; easily sol. in water.	2NH₄HB₂O₄·3H₂O, <i>acid ammonium metaborate</i>. Semi-transparent, rhombic or octahedral, efflor. cryst.; alkaline reaction and taste; sol. in water. (NH₄)₂B₄O₇·4H₂O, <i>ammonium borate, ammonium tetraborate, ammonium pyroborate</i>. Tetragonal cryst. that are generally found in turbid masses and smell strongly of NH₃; decomp. by heat; sol. in water. Unknown.
NaBrO₃, <i>sodium bromate</i>. Small, shiny, efflor. needles or cryst. powder; sol. in water, 27 g. in 100 g. of water at 0°, 34 g. at 20°, 91 g. at 100°; sp. gr. 3.3; M. P. 381°.	KBrO₃, <i>potassium bromate</i>. Cryst. powder, sometimes needles; sol. in hot water, 3 g. in 100 g. of water at 0°, 7 g. at 20°, 50 g. at 100°; sl. sol. in alcohol; melts at 370° and decomp. first slowly, then rapidly and explosively, giving off O₂ and Br₂; sp. gr. 3.2.	LiBrO₃, <i>lithium bromate</i>. Deliq. needles; sol. in water, 154 g. in 100 g. of water at 18°.	NH₄BrO₃, <i>ammonium bromate</i>. Colorless needles, with pungent taste; unstable; explodes on short exposure; sol. in water.

Bromate

Sodium	Potassium	Lithium	Ammonium	
NaBr, sodium bromide. Colorless or white, lustrous cubes; saline, feebly bitter or alkaline taste; not deliq. but absorbs moisture from air; sol. in water, approximately 66 g. in 100 g. of water at 0°, 77 g. at 20°, 114 g. at 100°; neutral reaction; very sl. sol. in alcohol; sp. gr. 3.2; M. P. 755°.	KBr, potassium bromide. Colorless or white, granular powder, or very lustrous, medium-sized, cubical cryst. that are sometimes elongated to prisms and sometimes flattened to plates; pungent, saline taste; crackles on heating; easily sol. in water with lowering of temp., 53 g. in 100 g. of water at 0°, 65 g. at 20°, 104 g. at 100°; sl. sol. in alcohol; sp. gr. 2.7; M. P. 730°.	LiBr, lithium bromide. White, deliq., sl. bitter granules or masses; sol. in water, 143 g. in 100 g. of water at 0°, 177 g. at 20°, 226 g. at 100°; sp. gr. 3.4; M. P. 547°.	NH₄Br, ammonium bromide. White, cryst. powder, or colorless, prismatic cryst.; pungent, saline taste; sublimates without decomp.; sol. in water with lowering of temp., 66 g. in 100 g. of water at 10°, 74 g. at 20°, 56 g. at 100°; sl. sol. in alcohol or ether; the aq. soln. gives off NH ₃ ; the salt turns yellow when exposed to moist air and acquires an acid reaction; sp. gr. 2.5.	Bromide
Na₂C₂, sodium carbide. White powder or cryst. masses; reacts with water, giving C ₂ H ₂ and NaOH; insol. in all solvents; dissociates into its elements when heated in vacuum; burns when heated gently in air or O ₂ , giving Na ₂ CO ₃ ; readily attacked by P and the halogens; burns spontaneously in HCl, forming NaCl, H ₂ and C; sp. gr. 1.575.	K₂C₂, potassium carbide, carburet of potassium. White powder or cryst. masses; resembles Na ₂ C ₂ closely.	Li₂C₂, lithium carbide. Transparent, colorless, cryst. masses; breaks easily to a white powder; powerful reducing agent; decomp. by cold water, forming LiOH and C ₂ H ₂ ; readily attacked by Br ₂ , I ₂ , O ₂ , S, P and As; inflames in F ₂ and Cl ₂ at ordinary temp.; insol. in concd. acids; sol. in fused oxidizing agents; sp. gr. 1.65.	Unknown.	Carbide
Na₂CO₃·10H₂O, sodium carbonate, sal soda, washing soda, soda, alkali, natron, soda ash, soda crystals, urao, Vichy salts, salt of soda, white alkali. Large, colorless, monoclinic cryst.; strong alkaline taste and reaction; efflor.; decomp. by acids, with evolution of CO ₂ ; sol. in water, 7 g. of the anhydrous salt in 100 g. of water at 0°, 21 g. at 20°, 45 g. at 100°; insol. in alcohol; sl. sol. in abs. alcohol; M. P.	K₂CO₃, potassium carbonate, pearl-ash, salt of tartar, potash, American ashes, fixed niter, salt of wormwood. White, very deliq., cryst. powder; strong alkaline reaction; decomp. by acids, with evolution of CO ₂ ; sol. in water, 89 g. in 100 g. of water at 0°, 112 g. at 20°, 156 g. at 100°; sol. in alcohol; insol. in abs. alcohol; M. P. 891°; sp. gr. 2.3.	Li₂CO₃, lithium carbonate. Light, white powder, small prisms, or cryst. crusts; alkaline reaction; not decomp. by heat; melts at low, red heat; decomp. by acids, with evolution of CO ₂ ; sl. sol. in water; more sol. in carbonic acid water; sol. in solns. of NH ₄ salts; insol. in alcohol; sp. gr. 2.1; M. P. 618°.	(NH₄)₂CO₃·H₂O, ammonium carbonate, normal ammonium carbonate, smelling salts, English salt, rock ammonia, salt of hartshorn, volatile salt. White, hard, translucent, striated masses or plates; strong NH ₃ odor; sharp, saline taste; efflor., first losing its cryst. water, and then decomp. on standing in air to the acid carbonate and NH ₃ ; decomp. at 85° to NH ₃ , CO ₂ and H ₂ O; sol. in water,	Carbonate

Na, K, Li, NH₄ GROUP

Carbonate Cont.

Sodium	Potassium	Lithium	Ammonium
34°; sp. gr. 1.4. Na₂CO₃ , <i>anhydrous sodium carbonate, dry soda</i> . Loose, white powder; other properties the same as of sal soda; sp. gr. 2.5; M. P. 851°.			100 g. in 100 g. of water at 15°, the soln. always having an odor of NH ₃ ; sol. in dil. NH ₄ OH; insol. in alcohol; the commercial salt is generally contaminated with the acid carbonate, NH ₄ HCO ₃ , and with ammonium carbamate, NH ₄ NH ₂ CO ₂ .
NaHCO₃ , <i>acid sodium carbonate, sodium bicarbonate, saleratus, baking soda, cooking soda, soda</i> . White, amorph. powder; cooling, mildly alkaline taste; mildly alkaline reaction; sol. in water, 7 g. in 100 g. of water at 0°, 10 g. at 20°, 16 g. at 100°; M. P. 1098°; sp. gr. 2.2.	KHCO₃ , <i>acid potassium carbonate, potassium bicarbonate, saleratus, potassium carbonate, bicarbonate of potash, kalicinite</i> . Colorless, transparent or translucent cryst.; sl. alkaline, saline taste; sol. in water, 22 g. in 100 g. of water at 0°, 33 g. at 20°, 60 g. at 60°; insol. in alcohol.	LiHCO₃ , <i>acid lithium carbonate, lithium bicarbonate</i> . Sol. in water.	NH₄HCO₃ , <i>acid ammonium carbonate, ammonium bicarbonate, smelling salts, Preston salts</i> . Large, transparent, trimetric cryst. or fine, dry, white powder; cooling, saline taste; strong NH ₃ odor; decomp. when heated into NH ₃ , CO ₂ and H ₂ O; sol. in water, 12 g. in 100 g. of water at 0°, 21 g. at 20°, 27 g. at 30°; insol. in alcohol.

Chlorate

Sodium	Potassium	Lithium	Ammonium
NaClO₃ , <i>sodium chlorate</i> . Colorless cryst.; cooling, saline taste; decomp. by heat or by strong acids; good oxidizing agent; sol. in water, 82 g. in 100 g. of water at 0°, 99 g. at 20°, 232 g. at 100°; sol. in cold alcohol, more easily in hot; M. P. 248°; sp. gr. 2.5.	KClO₃ , <i>potassium chlorate, potash</i> . Transparent, colorless, shiny prisms or monoclinic plates; pearly luster; cooling saline taste; a good oxidizing agent; decomp. with evolution of O ₂ when heated to 352°; decomp. by strong acids, often with explosive violence; sol. in water, with absorption of heat, 3 g. in 100 g. of water at 0°, 7 g. at 20°, 55 g. at 100°; sol. in alcohol; insol. in abs. alcohol; M. P. 368.4°; sp. gr. 2.3.	LiClO₃·H₂O , <i>lithium chlorate</i> . Very deliq., octahedra, or needles; decomp. when heated to 140°; melts at 50° in its cryst. water; M. P. of anhydrous salt is 129°; sol. in water, 213 g. in 100 g. of water at 18°; very easily sol. in alcohol.	NH₄ClO₃ , <i>ammonium chlorate</i> . Fine colorless needles or prisms; pungent taste; good oxidizing agent; sublimes somewhat above 100°; decomp. at 102°, with explosive violence to Cl ₂ , N ₂ O and H ₂ O; detonates when mixed and ground with combustible bodies; easily decomp. by strong acids; sol. in water; less sol. in alcohol; very sl. sol. in abs. alcohol; sp. gr. 1.9.

Chloride

Sodium	Potassium	Lithium	Ammonium
NaCl , <i>sodium chloride, salt, table salt, cooking salt, sea salt, rock salt, common salt, vacuum salt, halite, solar</i>	KCl , <i>potassium chloride, sylvine, bitter salts, sylvite, muriate of potash</i> . White, cubical cryst.; saline taste;	LiCl , <i>lithium chloride</i> . Colorless, very deliq., octahedral cryst.; probably the most deliq. salt known; sharp,	NH₄Cl , <i>ammonium chloride, sal ammoniac, sal-miak, ammonium muriate</i> . White, odorless, octahe-

Sodium	Potassium	Lithium	Ammonium	Chloride Cont.
<i>salt, bay salt, fossil salt, freezing salt, hopper salt, muriate of soda.</i> Colorless, transparent, cubic cryst., white, cryst. powder, or translucent to opaque lumps; pure, saline taste; neutral reaction; generally sl. deliq. on account of impurities; the pure salt is only sl. hygroscopic; crackles when heated; sol. in water, with sl. lowering of temp., 35 g. in 100 g. of water at 0°, 36 g. at 20°, 39 g. at 100°; sol. in alcohol, the solubility increasing with the temp.; insol. in ether; very sl. sol. in ether—absolute alcohol; M. P. 804°; volatile at higher temp.; sp. gr. 2.1.	stable in air; decrepitates when heated; sol. in water, 27 g. in 100 g. of water at 0°, 34 g. at 20°, 57 g. at 100°; sol. in alcohol; insol. in abs. alcohol; very sl. sol. in ether—absolute alcohol; M. P. 730°; volatile at higher temp.; sp. gr. 1.9.	saline taste, very similar to that of NaCl; melts at dark red heat to a clear liquid; volatile at white heat; very easily sol. in water, 67 g. in 100 g. of water at 0°, 78 g. at 20°, 127 g. at 100°; sol. in abs. alcohol, ether, and ether—alcohol; M. P. 613°; sp. gr. 2.	dral or cubical cryst., cryst. powder or translucent, fibrous, cryst. masses; pungent, salty taste; neutral reaction; sublimes completely and easily without melting at red heat; easily and quickly sol. in water, with lowering of temp., 29.4 g. in 100 g. of water at 0°, 37 g. at 20°, 77 g. at 100°; sol. in alcohol; very sl. sol. in abs. alcohol; insol. in ether; sp. gr. 1.5.	
$\text{Na}_2\text{CrO}_4 \cdot 10\text{H}_2\text{O}$, sodium chromate, sodium monochromate. Citron-yellow, transparent, efflor. or deliq., monoclinic prismatic cryst.; alkaline reaction; melts in its cryst. water at 23°; easily sol. in water, 24 g. of the anhydrous salt in 100 g. of soln. at 0°, 45 g. at 20°, 55 g. at 100°; sl. sol. in alcohol; sp. gr. 1.48.	K_2CrO_4 , potassium chromate, potassium monochromate, tarapacaité. Pale lemon-yellow, chunky, double, six-sided, trimetric pyramids; alkaline reaction; bitter, cooling, metallic taste; melts without change at red heat; easily sol. in water, 59 g. in 100 g. of water at 0°, 63 g. at 20°, 79 g. at 100°; insol. in alcohol; M. P. 975°; sp. gr. 2.7.	$\text{Li}_2\text{CrO}_4 \cdot 2\text{H}_2\text{O}$, lithium chromate, lithium monochromate. Red-brown, trimetric, prismatic cryst.; very easily sol. in water.	$(\text{NH}_4)_2\text{CrO}_4$, ammonium chromate, ammonium monochromate. Long, citron-yellow needles; emits odor of NH_3 in air; leaves Cr_2O_3 when heated; very sol. in water, 28.8 g. in 100 g. of saturated soln. at 30°; insol. in alcohol.	Chromate
$\text{Na}_2\text{Cr}_2\text{O}_7 \cdot 2\text{H}_2\text{O}$, sodium bichromate, sodium dichromate, red chromate of soda, bichrome, bichromate, chrome. Thin, hyacinth-red, deliq., triclinic prisms; sol. in water, more so than Na_2CrO_4 , 62 g. of the anhydrous salt in 100 g. of soln. at 0°, 64 g. at 18°, 81 g. at 98°; loses its	$\text{K}_2\text{Cr}_2\text{O}_7$, potassium bichromate, potassium dichromate, dichromate of potash, red chromate of potash, bichrome, chrome, bichromate. Large, orange-red, translucent, four-sided triclinic plates or prisms; stable in air; acid reaction; bitter, metallic taste; decrepitates	$\text{Li}_2\text{Cr}_2\text{O}_7 \cdot 2\text{H}_2\text{O}$, lithium bichromate, lithium dichromate. Dark bluish gray or brownish black, deliq., finely cryst. powder; sol. in water.	$(\text{NH}_4)_2\text{Cr}_2\text{O}_7$, ammonium bichromate, ammonium dichromate. Orange or red, monoclinic prisms decomp. at red heat, with explosive violence, leaving Cr_2O_3 ; sol. in water, less so than the normal chromate.	

Na, K, Li, NH₄ GROUP

	Sodium	Potassium	Lithium	Ammonium
Chromate <i>Cont.</i>	cryst. water at 110°; melts at 320° and decomp. at 400°; sp. gr. 2.5.	when heated; melts near red heat, and decomp. at white heat; sol. in water, less so than K ₂ CrO ₄ , 5 g. in 100 g. of water at 0°, 12 g. at 20°, 97 g. at 100°; insol. in alcohol; M. P. 398°; sp. gr. 2.7.		
Cyanide	NaCN, sodium cyanide, cyanogen, cyanegg. White deliq., cryst., poisonous powder; cryst. with difficulty; sol. in water; M. P. 563°.	KCN, potassium cyanide. White, opaque, amorph., deliq. lumps or powder, occasionally, small, white cubes or octahedra; very poisonous; alkaline reaction; melts easily, and volatilizes at red heat; emits odor of HCN; sol. in water, 122 g. in 100 g. of water; somewhat sol. in alcohol; less sol. in abs. alcohol; M. P. 634°; sp. gr. 1.5.	Unknown.	NH ₄ CN, ammonium cyanide. Colorless cubes; alkaline reaction; very poisonous; volatilizes at 36°, with dissociation into HCN and NH ₃ ; vapor is inflammable in air; decomp. easily in air to brownish mass; easily sol. in water; easily sol. in alcohol.
Ferrocyanide	Na ₄ Fe(CN) ₆ ·12H ₂ O, sodium ferrocyanide, yellow prussiate of soda, ferroproussiate of sodium. Pale yellow, transparent, efflor., monoclinic prisms; sol. in water, less so than K ₄ Fe(CN) ₆ , 18 g. in 100 g. of water at 20°, 63 g. at 98°; insol. in alcohol; sp. gr. 1.5.	K ₄ Fe(CN) ₆ ·3H ₂ O, potassium ferrocyanide, yellow prussiate of potash, ferroproussiate of potassium. Lemon yellow to amber yellow, efflor., monoclinic, tabular cryst.; seldom separate, usually massed together irregularly; pearly luster; loses all its cryst. water at 60° to 80°; decomp. when heated to a higher temp.; sol. in water to yellow solution that decomposes in sunlight, with formation of Prussian blue; more sol. in hot than in cold water, approximately 13 g. in 100 g. of water at 0°, 25 g. at 20°, 76 g. at 100°; insol. in alcohol.	Li ₄ Fe(CN) ₆ ·9H ₂ O, lithium ferrocyanide. Deliq. cryst.; very sol. in water.	(NH ₄) ₄ Fe(CN) ₆ ·3H ₂ O, ammonium ferrocyanide. White or greenish cryst. that turn blue in the air or when heated with formation of Fe(CN) ₂ (?) and NH ₄ CN; easily sol. in water; insol. in alcohol.
Ferricyanide	Na ₃ Fe ₂ (CN) ₁₁ ·2H ₂ O, sodium fer-	K ₃ Fe ₂ (CN) ₁₁ , potassium ferricyan-	Unknown.	(NH ₄) ₃ Fe ₂ (CN) ₁₁ ·3H ₂ O, ammonium

Sodium	Potassium	Lithium	Ammonium	
<i>ricyanide, red prussiate of soda.</i> Ruby-colored, deliq. prisms; sol. in cold water to a yellowish soln.; very easily sol. in hot water; insol. in alcohol.	<i>ide, red prussiate of potash.</i> Large, red, monoclinic prisms or needles, which when crushed give a yellow powder; easily sol. in water to a greenish soln., approximately 31 g. in 100 g. of water at 0°, 43 g. at 20°, 66 g. at 60°; insol. in abs. alcohol; sl. sol. in dil. alcohol; sp. gr. 1.9.		<i>ferricyanide.</i> Ruby red, shiny, monoclinic prisms or tablets; stable in air; when heated it loses some of its cryst. water, and then decomp. with formation of HCN; sol. in water; probably sol. in alcohol.	Ferri- cyanide Cont.
NaF, sodium fluoride, villiumite. Clear, colorless, lustrous, sometimes opalescent, cubical cryst.; alkaline reaction; more bitter taste than KF; decrepitates when heated; very sl. sol. in cold water, 4 g. in 100 g. of soln. at 18°; heating does not increase solubility; almost insol. in alcohol; M. P. 980°; sp. gr. 2.8.	KF, potassium fluoride. White, deliq., alkaline, cryst. powder or cubes; sharp, saline taste; sol. in water, 92 g. in 100 g. of water at 18°; soln. etches glass; insol. in alcohol; M. P. 880°; sp. gr. 2.5.	LiF, lithium fluoride. White powder or small cryst. tablets; very difficultly sol. in water; M. P. 870°; sp. gr. 2.3.	NH₄F, ammonium fluoride. Small, colorless, hexagonal, flat or prismatic cryst.; generally stable in air, tho sometimes deliq.; etches glass; strong saline taste; sublimes unchanged with previous melting, and more easily than NH ₄ Cl; easily sol. in water; sl. sol. in alcohol.	Fluoride
NaHF₂, acid sodium fluoride. Small, colorless, rhombohedral cryst.; sharp, acid taste; decomp. by heat into NaF and HF; sl. sol. in cold water, more in hot.	KHF₂, acid potassium fluoride, Freney's salt. White cubes or four-sided tablets; decomp. by heat into KF and HF; easily sol. in water; sol. in dil. alcohol, but insol. in abs. alcohol.	LiHF₂, acid lithium fluoride. Small cryst.; very sour taste; decomp. by heat into LiF and HF; difficultly sol. in water, but more easily sol. than LiF.	NH₄HF₂, acid ammonium fluoride. Colorless, sl. deliq. chunky or prismatic cryst.; volatilizes easily to acrid vapor; easily sol. in water.	
AlF₃.3NaF, v. aluminium sodium fluoride.				
NaH, sodium hydride. Colorless cryst. powder or white cryst.; decomp. by water, evolving H ₂ ; burns when heated in dry air; ignites spontaneously in moist air; burns brilliantly in F ₂ , Cl ₂ , and NO ₂ ; decomp. by HCl, HNO ₃ and H ₂ SO ₄ ; insol. in organic solvents and in liquid NH ₃ ; sol. in fused Na or Na amalgam; non-conductor of elec-	KH, potassium hydride. Slender white needle cryst. resembles NaH closely; ignites spontaneously in F ₂ , Cl ₂ and O ₂ ; decomp. by water, evolving H ₂ ; insol. in CS ₂ and organic solvents; non-conductor of electricity; sol. in fused K; decomp. when heated; sp. gr. 0.80. <i>K₂H</i> said to exist.	LiH, lithium hydride. Hard, white solid; not deliq.; slowly altered in air; decomp. by water, evolving H ₂ ; decomp. when heated slowly; ignites in Cl ₂ ; non-conductor of electricity; attacked by hot, but not by cold Cl ₂ ; M. P. 680°; sp. gr. 0.820.	Unknown.	Hydride

Na, K, Li, NH₄ GROUP

	Sodium	Potassium	Lithium	Ammonium
Hydride <i>Cont.</i>	tricity; reduces certain metallic oxides; sp. gr. 0.92. Na₂H₄ , sodium hydride. Decomp. violently by water. <i>Na₂H</i> said to exist.			
Hydroxide	NaOH , sodium hydroxide, sodium hydrate, caustic soda, soda, caustic, alkali, mineral alkali, white caustic. White, hard, brittle, very deliq. sticks or amorph. powder; strong, alkaline reaction; absorbs CO ₂ from the air; dissolves in water, with evolution of great heat, 42 g. in 100 g. of water at 0°, 109 g. at 20°, 313 g. at 80°; easily sol. in alcohol, wood spirit or glycerine; somewhat sol. in ether; melts below red heat; volatilizes at very bright red heat or higher than KOH; M. P. 318°; sp. gr. 2.1.	KOH , potassium hydroxide, potassium hydrate, caustic potash, potash, vegetable alkali. White, hard, brittle, very deliq. sticks or amorph. powder; sticks often show fibrous or radiated structure; absorbs CO ₂ from the air; strongly alkaline reaction; sl. nauseous odor; strongly acrid taste; a strong potential cautery; easily sol. in water, giving great heat, 97 g. in 100 g. of water at 0°, 112 g. at 20°, 178 g. at 100°; easily sol. in alcohol, wood spirit and glycerine; sl. sol. in ether; melts below red heat; volatilizes at bright red heat to white, pungent vapor; decomp. at white heat; M.P. 260°; sp. gr. 2.	LiOH , lithium hydroxide, lithium hydrate. White, transparent, sl. deliq., amorph. powder or cryst. masses; strongly alkaline reaction; absorbs CO ₂ from the air; melts at 450° without decomp.; sol. in water, but less so than NaOH or KOH, 13 g. in 100 g. of water at 0° and 20°, 17 g. at 100°; sl. sol. in alcohol; sp. gr. 2.5.	NH₄OH , ammonium hydroxide, ammonium hydrate, aqua ammonia, spirits of hartshorn. Known only in solution; colorless; very alkaline; has pungent, characteristic odor.
Hypochlorite	NaOCl , sodium hypochlorite, Javelle water, Labarraque's solution. Fine, tetragonal needles which are more stable than their soln., or an amorph. powder which melts at c. 45°; unstable; seldom found pure; usually contaminated with NaCl, NaOH and NaClO ₃ ; dil. acids liberate all the Cl ₂ ; found usually in water soln., which slowly changes to NaCl and NaClO ₃ on standing; water	KOCl , potassium hypochlorite, Javelle water. Said to be white needles; known only in soln., which, like NaOCl, acts as a bleaching agent; decomp. when heated.	LiOCl , lithium hypochlorite. Known only in soln.	NH₄OCl , ammonium hypochlorite. Known only in soln. which decomp. immediately.

Sodium	Potassium	Lithium	Ammonium	
soln. bleaches; occasionally explosive when kept in closed containers.				Hypo-chlorite Cont.
NaH₂PO₃·H₂O , <i>sodium hypophosphite</i> . Small, colorless, pearly, rectangular plates or white, granular powder; very deliq.; bitterish, sweet, saline taste; evaporation of an aq. soln. is often attended with explosions; sol. in water, less so than the K salt; easily sol. in abs. alcohol.	KH₂PO₃ , <i>potassium hypophosphite</i> . White, granular powder or opaque, white, hexagonal tablets; very deliq.; pungent, saline taste; decomp. with explosive violence when crushed; burns with a yellow flame; easily sol. in water or alcohol.	LiH₂PO₃·H₂O , <i>lithium hypophosphite</i> . Colorless, transparent, monoclinic cryst.; sol. in water.	NH₄H₂PO₃ , <i>ammonium hypophosphite</i> . Irregular, hexagonal scales; less deliq. than the K salt; decomp. when heated; sol. in water; easily sol. in alcohol; M. P. 200°.	Hypo-phosphite
NaIO₃ , <i>sodium iodate</i> . Opaque, silky needles that sometimes contain water of cryst., the amount depending upon the temp. at which the cryst. were formed; melts when heated; decomp. at a higher temp.; sol. in water, 2.5 g. in 100 g. of water at 0°, 9 g. at 20°, 34 g. at 100°; insol. in alcohol.	KIO₃ , <i>potassium iodate</i> . Small, hard, white, lustrous, cubical cryst.; decomp. at a higher temp. than KClO ₃ ; melts at 560° with partial decomp.; sol. in water, 5 g. in 100 g. of water at 0°, 8 g. at 20°, 32 g. at 100°; sol. in warm, dil. H ₂ SO ₄ ; insol. in alcohol; sp. gr. 3.9.	2LiIO₃·H₂O , <i>lithium iodate</i> . Cryst., crusts or deliq. needles with pearly luster; easily sol. in water, 80 g. in 100 g. of water at 18°; insol. in alcohol.	NH₄IO₃ , <i>ammonium iodate</i> . Colorless prisms or cryst. powder; decomp. with hissing, when heated to 150°; sl. sol. in water; sp. gr. 3.3.	Iodate.
NaI , <i>sodium iodide</i> . White, cubic cryst. or white, fibrous masses with pearly luster; sl. bitter taste; deliq. in moist air, becoming rose-colored with separation of some I ₂ and formation of some Na ₂ CO ₃ ; M. P. 628°; volatilizes less readily than KI but at a lower temp. than NaCl; sol. in water, 158 g. in 100 g. of water at 0°, 178 g. at 20°, 302 g. at 100°; from an aq. soln. NaI·2H ₂ O usually separates out below 65° and NaI above 65°; sol. in alcohol.	KI , <i>potassium iodide</i> . Colorless, transparent or translucent, hard, cubical cryst. or white, granular powder; pungent, saline taste; stable in dry air; deliq. only in very moist air; very sol. in water, with considerable lowering of temp., 127 g. in 100 g. of water at 0°, 144 g. at 20°, 208 g. at 100°; sol. in alcohol; M. P. 773°; sp. gr. 3.1.	LiI , <i>lithium iodide</i> . White to colorless prisms or white to brownish, deliq. powder, which turns yellow or brown on standing, on account of separation of some free I ₂ ; sol. in water, 151 g. in 100 g. of water at 0°, 165 g. at 20°, 263 g. at 75°; M. P. 446°; sp. gr. 4.	NH₄I , <i>ammonium iodide</i> . Colorless cubes or white, hygroscopic, odorless, cryst. powder; sharp, saline taste; deliq. in moist air and becomes yellow thru separation of I ₂ and loss of NH ₃ ; in absence of air it sublimes unchanged and without melting; decomp. when heated in air; easily sol. in water or alcohol; sp. gr. 2.5.	Iodide

Na, K, Li, NH₄ GROUP

	Sodium	Potassium	Lithium	Ammonium
Manganate	Na₂MnO₄·10H₂O, <i>sodium manganate</i>. Cryst.; colorless when pure, but generally dark green; sol. in water with partial decomp. to form a green soln. NaMnO₄·3H₂O, <i>sodium permanganate</i>, <i>Conde's liquid</i>. Black deliq., granular powder; cryst. with difficulty on account of great solubility in water.	K₂MnO₄, <i>potassium manganate</i>, <i>chameleon mineral</i>. Dark green, rhombic cryst. with metallic luster; turns dull and black in air; decomp. when heated to a high temp.; sol. in water, with decomp. to KMnO₄ and MnO₂; sol. in KOH + Aq. from which it may be cryst. KMnO₄, <i>potassium permanganate</i>. Dark purple-red, almost black, slender, opaque prisms; blue metallic reflection; sweet taste, with astringent, bitter after-taste; decomp. at high heat; sol. in water, 3 g. in 100 g. of water at 0°, 8 g. at 25°, 20 g. at 65°; aq. soln. is violet to purple when dil., dark red to nearly black when concd.; decomp. immediately by alcohol; sp. gr. 2.7.	Unknown. LiMnO₄·3H₂O, <i>lithium permanganate</i>. Stable cryst.; sol. in water.	Unknown. NH₄MnO₄, <i>ammonium permanganate</i>. Slender prisms; sol. in water, 8 g. in 100 g. of water at 15°.
Molybdate	Na₂MoO₄·2H₂O, <i>sodium molybdate</i>, <i>normal sodium molybdate</i>. Small tablets, with mother of pearl luster; alkaline reaction; sol. in water, 30 g. of the anhydrous salt in 100 g. of soln. at 0°, 39 g. at 18°, 45 g. at 100°.	K₂MoO₄, <i>potassium molybdate</i>. White, finely cryst. powder; deliq.; very sol. in water; insol. in alcohol; M. P. 919°; sp. gr. 2.3.	5Li₂MoO₄·2H₂O, <i>lithium molybdate</i>, <i>normal lithium molybdate</i>. Thin prisms or cryst. warts; sol. in water.	(NH₄)₂MoO₄, <i>ammonium molybdate</i>. Small, four-sided, colorless prisms that efflor. in air by loss of NH₃; decomp. by water into an acid molybdate; sol. in dil. NH₄Cl + Aq. (NH₄)₂PO₄, 12MoO₃, (?) <i>ammonium phosphomolybdate</i>. Yellow powder of variable composition; sl. sol. in water; sol. in alkalies.
Nitrate	NaNO₃, <i>sodium nitrate</i>, <i>Chili saltpeter</i>, <i>cubic saltpeter</i>, <i>cubic niter</i>, <i>Chili niter</i>, <i>nitratine</i>, <i>soda niter</i>, <i>soda</i>	KNO₃, <i>potassium nitrate</i>, <i>saltpeter</i>, <i>niter</i>, <i>sal Prunella</i>, <i>potash saltpeter</i>, <i>potash niter</i>, <i>saltpeter flour</i>, <i>pris-</i>	LiNO₃, <i>lithium nitrate</i>. Transparent, very deliq. cryst., sometimes needles; taste resembles that of KNO₃;	NH₄NO₃, <i>ammonium nitrate</i>. Colorless or white deliq. odorless cryst.; usually long, thin, rhombic prisms;

Sodium	Potassium	Lithium	Ammonium	Nitrate Cont.
<i>saltpeter, caliche, Peru saltpeter.</i> Colorless, sl. deliq., transparent, rhombohedral cryst., that are nearly cubical; saline, sl. bitter taste; sol. in water, with lowering of temp., 73 g. in 100 g. of water at 0°, 87 g. at 20°, 180 g. at 100°; sol. in solns. of several salts of alkali metals; sol. in alcohol; M. P. 308°; sp. gr. 2.2.	<i>matic niter.</i> Colorless, transparent, six-sided prisms or a white, cryst. powder; cooling, saline, pungent taste; sol. in water, with lowering of temp., 13 g. in 100 g. of water at 0°, 32 g. at 20°, 246 g. at 100°; insol. in abs. alcohol; in dil. alcohol it dissolves proportionally to the amount of water present; M. P. 333°; decomp. at white heat; sp. gr. 2.1.	melts at 255° to a clear liquid; sol. in water, 34 g. in 100 g. of soln. at 0°, 43 g. at 21°, 66 g. at 70°; sol. in strong alcohol; sp. gr. 1.7.	sharp bitter taste; deliq. in air, losing NH ₃ and acquiring an acid reaction; melts at c. 152°; decomp. begins at c. 210° and becomes explosive at c. 300°; products are H ₂ O and N ₂ O, but part of the salt volatilizes; sol. in water with lowering of temp., 118 g. in 100 g. of water at 0°, 192 g. at 20°, 871 g. at 100°; sol. in alcohol; sp. gr. 1.6.	
NaNO₂, sodium nitrite. Colorless, transparent, hexagonal cryst.; less deliq. than KNO ₃ ; mildly saline taste; alkaline reaction; very sol. in water, more so than NaNO ₃ ; insol. in abs. alcohol; M. P. 271°; sp. gr. 2.1.	KNO₂, potassium nitrite. White to yellowish white, amorph., deliq. sticks or lumps, resembling KOH or colorless, microscopic, prismatic cryst.; very sol. in water, 300 g. in 100 g. of water at 15°; more sol. than KNO ₃ ; insol. in abs. alcohol; M. P. 297°; sp. gr. 1.9. Co(NO₂)₃.3KNO₃ <i>v.</i> Co nitrite.	2LiNO₂.H₂O, lithium nitrite. Deliq., sl. alkaline cryst. masses; easily sol. in water and in alcohol.	NH₄NO₂, ammonium nitrite. Tough, elastic, cryst. masses, indistinct cryst., or clear yellow liquid; peculiar characteristic odor; very deliq.; decomp. by heat; sometimes decomp. simply on standing; detonates at 60° or under sudden blows; sol. in water.	Nitrite
Na₂C₂O₄, sodium oxalate, normal sodium oxalate. Fine, white powder; sl. sol. in water, with neutral reaction, 3 g. in 100 g. of water at 15°, 6 g. at 100°. NaHC₂O₄, acid sodium oxalate. Monoclinic, cryst. with acid reaction on litmus.	K₂C₂O₄, potassium oxalate. Small, colorless, transparent, monoclinic cryst.; sol. in water. KHC₂O₄, acid potassium oxalate, salt of sorrel, sorrel salt, salts of lemon. Monoclinic cryst.; sol. in water.	Li₂C₂O₄, lithium oxalate, normal lithium oxalate. Small, white cryst.; sol. in water; sp. gr. 2.1. LiHC₂O₄, acid lithium oxalate. Sol. in water.	(NH₄)₂C₂O₄.H₂O, ammonium oxalate, normal ammonium oxalate. Long, shiny, rhombic, prismatic cryst.; sol. in water. NH₄HC₂O₄, acid ammonium oxalate. Prismatic cryst.	Oxalate
Na₂O, sodium oxide, sodium monoxide. Grayish white, amorph. powder; probably always contaminated with Na ₂ O ₂ ; very deliq.; sol. in water, with evolution of heat and formation of	K₂O, potassium oxide, potassium monoxide. Grayish white, brittle, non-lustrous, solid with conchoidal fracture; often contaminated with K ₂ O ₂ ; sol. in water, with evolution of much	Li₂O, lithium oxide, lithium monoxide. White, cryst. solid; deliq. more slowly than NaOH; slowly sol. in water, with formation of LiOH; melts with decomp.; M. P. >	Unknown.	Oxide

Na, K, Li, NH₄ GROUP

Oxide Cont.

Sodium	Potassium	Lithium	Ammonium
NaOH; melts at strong heat.	heat and formation of KOH; melts at full red heat; volatilizes at very high temp.; sp. gr. 2.3.	1700°; sp. gr. 2.	
Na ₂ O ₂ , sodium dioxide, sodium peroxide, ozone, oxygen powder. Yellowish white, amorph. powder; deliq. gradually in air and absorbs CO ₂ , forming solid Na ₂ CO ₃ ; easily sol. in water, with evolution of much heat and formation of NaOH; a good oxidizing agent; evolves O ₂ when heated.	K ₂ O ₄ , potassium tetroxide, potassium superoxide, potassium peroxide. Dark yellow, amorph. powder, resembling PbCrO ₄ in color; deliq. in moist air, giving off O ₂ ; sol. in water, with evolution of much heat and formation of KOH and H ₂ O ₂ ; softens at 280°; melts at red heat to a black transparent fluid, that deposits leaflets on cooling; decomp. at white heat.	Li ₂ O ₂ , lithium dioxide, lithium peroxide. Yellow powder; sol. in water, with evolution of heat and formation of LiOH.	Unknown.

Phosphate

Na ₃ PO ₄ ·12H ₂ O, sodium phosphate, normal sodium phosphate, neutral sodium phosphate, trisodium orthophosphate, tertiary sodium phosphate. Clear, colorless, six-sided cryst., prisms or pyramids; cooling, saline taste; sol. in water probably with decomp., 1.5 g. in 100 g. of water at 0°, 11 g. at 20°, 108 g. at 100°; M. P. 73.4°; sp. gr. 1.6.	K ₂ PO ₄ , potassium phosphate, normal potassium phosphate, neutral potassium phosphate, tripotassium orthophosphate, tertiary potassium phosphate. White solid, small needles or cryst. powder; not deliq.; somewhat sol. in cold water, more sol. in hot; insol. in alcohol; melts at red heat; decomp. at white heat; M. P. 1340°.	2Li ₃ PO ₄ ·H ₂ O, lithium phosphate, normal lithium phosphate, neutral lithium phosphate, trilithium orthophosphate, tertiary lithium phosphate. Heavy, white, granular, cryst. powder; very sl. sol. in water; more sol. in solns. of NH ₄ salts; easily sol. in acids; does not melt even at white heat.	(NH ₄) ₃ PO ₄ ·3H ₂ O, ammonium phosphate, normal ammonium phosphate, neutral ammonium phosphate, triammonium orthophosphate, tertiary ammonium phosphate. Semi-solid, cryst. masses or short, prismatic needles; changes rapidly to (NH ₄) ₂ HPO ₄ ; sol. with difficulty in water; less sol. than (NH ₄) ₂ HPO ₄ ; insol. in solns. of alkalies.
Na ₂ HPO ₄ ·12H ₂ O, sodium phosphate, acid sodium phosphate, disodium orthophosphate, secondary sodium phosphate, ordinary sodium phosphate. Colorless, translucent, monoclinic prisms or white, cryst. powder; cooling, saline taste; efflor. in air, losing 5H ₂ O; all the cryst. water goes off at 100°; sol. in water, 2.5 g. in 100 g. of water at 0°, 9.3 g. at 20°	K ₂ HPO ₄ , potassium phosphate, acid potassium phosphate, dipotassium orthophosphate, secondary potassium phosphate. White, amorph. or sl. cryst., deliq. powder; sour taste; acid reaction; very sol. in water or alcohol; decomp. when heated.	Li ₂ HPO ₄ , lithium phosphate, acid lithium phosphate, dilithium orthophosphate, secondary lithium phosphate. Nearly insol. in water.	(NH ₄) ₂ HPO ₄ , ammonium phosphate, acid ammonium phosphate, diammonium orthophosphate, secondary ammonium phosphate. Colorless, odorless, translucent, monoclinic prisms; cooling, saline taste; efflor. in air, leaving NH ₄ H ₂ PO ₄ ; easily sol. in water; insol. in alcohol; aq. soln. is alkaline and loses NH ₃ when boiled.

Sodium	Potassium	Lithium	Ammonium
99 g. at 100°; insol. in alcohol; melts in its cryst. water at 34.6°; sp. gr. 1.5. NaH₂PO₄·H₂O , sodium phosphate, acid sodium phosphate, monosodium orthophosphate, primary sodium phosphate. Cryst. powder; cryst. sometimes rhombic, sometimes monoclinic; acid reaction; very sol. in water; insol. in alcohol; decomp. at 200°.	KH₂PO₄ , potassium phosphate, acid potassium phosphate, monopotassium orthophosphate, primary potassium phosphate. Colorless, transparent, tetragonal cryst.; sour taste; acid reaction; deliq.; easily sol. in water; insol. in alcohol; changes above 204° to KPO ₃ and then melts.	LiH₂PO₄ , lithium phosphate, acid lithium phosphate, monolithium orthophosphate, primary lithium phosphate. Deliq. cryst. with acid reaction; very sol. in water.	NH₄H₂PO₄ , ammonium phosphate, acid ammonium phosphate, monoammonium orthophosphate, primary ammonium phosphate. Tetragonal cryst., that do not efflor.; sol. in water, less so than (NH ₄) ₂ HPO ₄ .
NaPO₃ , sodium metaphosphate, monosodium metaphosphate. Clear, glassy, transparent, colorless sticks or powder; sparingly sol. in water; M. P. 617°.	KPO₃ , potassium metaphosphate, monopotassium metaphosphate. Cryst. powder; sparingly sol. in water.	Unknown.	NH₄PO₃ , ammonium metaphosphate, monoammonium metaphosphate. Insol. in cold water; sol. in hot water.
Na₂P₂O₇·10H₂O , sodium pyrophosphate. Colorless, monoclinic cryst.; sol. in water, 3 g. in 100 g. of water at 0°, 6 g. at 20°, 40 g. at 100°; insol. in alcohol; sp. gr. 1.8.	K₂P₂O₇·3H₂O , potassium pyrophosphate. White, very deliq., radiating masses; easily sol. in water; insol. in alcohol.	Li₂P₂O₇·2H₂O , lithium pyrophosphate. Sparingly sol. in water.	(NH₄)₂P₂O₇ , ammonium pyrophosphate. Cryst. tablets; alkaline reaction; easily sol. in water; insol. in alcohol.
NaNH₄HPO₄·4H₂O , sodium-ammonium phosphate, sodium-ammonium-hydrogen phosphate, microcosmic salt, salt of phosphorus, stercorite, phosphorus salt, fusible salt of urine, fusible salt, essential salt of urine. Transparent, colorless, efflor., monoclinic cryst.; easily sol. in water; insol. in alcohol; aq. soln. gives off NH ₃ , especially if hot; when salt is heated H ₂ O and NH ₃ go off, leaving NaPO ₃ ; fused salt is easily colored by metallic oxides; M. P. c. 79° with decomp.; sp. gr. 1.5.			NH₄MgPO₄·6H₂O , ammonium-magnesium phosphate. Colorless, rhombic cryst. or white, cryst. powder; alkaline reaction; loses NH ₃ in air; sl. sol. in water; sol. in dil. acids; insol. in water containing ammonium phosphate or sodium-ammonium phosphate; decomp. when heated.

Phosphate
Cont.

Na, K, Li, NH₄ GROUP

	Sodium	Potassium	Lithium	Ammonium
Phosphite	$\text{Na}_2\text{HPO}_3 \cdot 5\text{H}_2\text{O}$, sodium phosphite, normal sodium phosphite. White, cryst. powder; very deliq.; very sol. in water; insol. in alcohol; M. P. 53°. $2\text{NaH}_2\text{PO}_3 \cdot 5\text{H}_2\text{O}$, acid sodium phosphite. Monoclinic prisms; very sol. in water; M. P. 42°; loses most of its cryst. water at 100°; decomp. above 130°.	K_2HPO_3, potassium phosphite, normal potassium phosphite. White, semi-cryst., syrup-like mass, with small cryst.; very deliq.; easily sol. in water; insol. in alcohol. KH_2PO_3, acid potassium phosphite. Monoclinic prisms; sol. in water.	Unknown. LiH_2PO_3, acid lithium phosphite. Small cryst.; very sol. in water; stable at 100°; decomp. at higher temp.	$(\text{NH}_4)_2\text{HPO}_3 \cdot \text{H}_2\text{O}$, ammonium phosphite, normal ammonium phosphite. Colorless, very deliq., four-sided, prismatic cryst.; sol. in water; insol. in alcohol; loses H_2O and NH_3 at 100°. $\text{NH}_4\text{H}_2\text{PO}_3$, acid ammonium phosphite. Very deliq., monoclinic prisms; sol. in water, 171 g. in 100 g. of water at 0°, 190 g. at 14.5°, 260 g. at 31°; absorbs NH_3 at 80° to 100°, forming the normal phosphite; melts at 123°; decomp. above 150°.
Silicate	$\text{Na}_2\text{SiO}_3 + \text{Aq}$, sodium silicate, sodium metasilicate, soda water glass, water glass, soluble glass, soluble soda glass, glass liquor. White to grayish white or bluish white, hard, cryst. lumps or flat pieces, with glassy luster; sometimes occurs as a syrup or jelly-like mass; sol. in water.	K_2SiO_3, potassium silicate, potassium metasilicate, water glass, potash water glass, soluble glass, soluble potash glass, glass liquor. Translucent to transparent, sl. deliq., glass-like lumps; sometimes occurs as a colorless sl. turbid, syrupy, alkaline, odorless liquid; sol. in water; M. P. 976°.	Li_2SiO_3, lithium silicate, lithium metasilicate, lepidolite (impure). Colorless and transparent; sol. in water; M. P. 1201°; sp. gr. 2.3.	Unknown.
Silico-fluoride	Na_2SiF_6, sodium silicofluoride, sodium fluosilicate, salufer. White, gelatinous ppt. or granular cryst. powder; more sol. in water than the K salt; insol. in alcohol; melts at red heat, giving off SiF_4; sp. gr. 2.7.	K_2SiF_6, potassium silicofluoride, potassium fluosilicate, hieratite. Fine, white powder; or microscopic, rhombohedral or hexagonal, tessellated, prismatic needles; very sol. in water; easily sol. in hot water; insol. in alcohol; melts at low red heat, and then decomp. into SiF_4 and KF; sp. gr. 2.6.	$\text{Li}_2\text{SiF}_6 \cdot 2\text{H}_2\text{O}$, lithium silicofluoride, lithium fluosilicate. Large, transparent, somewhat lustrous, deliq., monoclinic, prismatic cryst.; sol. in water, giving an acid soln.; sol. in alcohol; loses its cryst. water at 100°; melts at low red heat and then decomp., giving SiF_4.	$(\text{NH}_4)_2\text{SiF}_6$, ammonium silicofluoride, ammonium fluosilicate, cryptohalite. White, cryst. powder; sol. in water; decrepitates and sublimates when heated.
Sulfate	$\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$, sodium sulfate, normal sodium sulfate, Glauber's salt, mirabilite, salt cake,	K_2SO_4, potassium sulfate, normal potassium sulfate, glazier's salt, arcanite, salt of Lem-	$\text{Li}_2\text{SO}_4 \cdot \text{H}_2\text{O}$, lithium sulfate, normal lithium sulfate. Stable or sl. efflor., white powder or	$(\text{NH}_4)_2\text{SO}_4$, ammonium sulfate, normal ammonium sulfate, mascagnine. Small, colorless,

Sodium	Potassium	Lithium	Ammonium
<i>verde salt</i> . Large, colorless to white, striated, sl. efflor., monoclinic prisms; sol. in water, 5 g. of the anhydrous salt in 100 g. of water at 0°, 19 g. at 20°, 42 g. at 100°; insol. in abs. alcohol; somewhat sol. in dil. alcohol; melts at 32.4°, separating into a saturated soln. and the anhydrous salt; sp. gr. 1.4.	<i>ery</i> . Small, hard, colorless, transparent, rhombic, six-sided pyramids or prisms; or white, hard, four-sided, trimetric prisms; or white powder; saline taste; sol. in water, 7 g. in 100 g. of water at 0°, 11 g. at 20°, 24 g. at 100°; insol. in alcohol; M. P. 1073°; volatilizes on long heating to a white, non-alkaline vapor; sp. gr. 2.6.	small, thin, monoclinic plates; saline taste; decrepitates when heated, and loses its cryst. water at 130°; sol. in water; sp. gr. 2. Li₂SO₄ , <i>anhydrous lithium sulfate</i> . White, sl. hygroscopic masses; saline taste; more sol. in cold than in hot water, 26 g. in 100 g. of water at 0°, 25 g. at 20°, 23 g. at 100°; sol. in alcohol; M. P. 860°; sp. gr. 2.2.	transparent, rhombic cryst. or cryst. powder; sharp, bitter taste; sol. in water, with absorption of heat, 71 g. in 100 g. of water at 0°, 75 g. at 20°, 103 g. at 100°; insol. in abs. alcohol; M. P. 513° with decomp.; sp. gr. 1.7.
Na₂SO₄ , <i>anhydrous sodium sulfate, thenardite</i> . Colorless, octahedral, rhombic cryst. or white, amorph. powder; sol. in water; M. P. 865°; sp. gr. 2.7.			
NaHSO₄ , <i>acid sodium sulfate, sodium bisulfate, niter cake, sally nixon</i> . Large, long, colorless, four-sided triclinic cryst. or grayish masses; sol. in water, with decomp.; decomp. by alcohol; M. P. above 315°; decomp. at white heat; sp. gr. 2.7. Na₂Al₂(SO₄)₄·24H₂O <i>v.</i> Al sulfate. Na₂Cr₂(SO₄)₄·24H₂O <i>v.</i> Cr sulfate. Na₂Fe(SO₄)₂·4H₂O <i>v.</i> Fe(ous) sulfate. Na₂Mn(SO₄)₂·2H₂O <i>v.</i> Mn sulfate. Na₂Zn(SO₄)₂·4H₂O <i>v.</i> Zn sulfate.	KHSO₄ , <i>acid potassium sulfate, potassium bisulfate, miscenite</i> . Colorless or white, more or less moist, rhombohedral plates; efflor.; strong, acid taste and reaction; sol. in water, 36 g. in 100 g. of water at 0°, 51 g. at 20°, 122 g. at 100°; alcohol dissolves out the H ₂ SO ₄ ; M. P. 197°; decomp. at white heat. K₂Al₂(SO₄)₄·24H₂O <i>v.</i> Al sulfate. K₂Cr₂(SO₄)₄·24H₂O <i>v.</i> Cr sulfate. K₂Fe(SO₄)₂·6H₂O <i>v.</i> Fe(ous) sulfate. K₂Fe₂(SO₄)₄·24H₂O <i>v.</i> Fe(ic) sulfate. K₂Co(SO₄)₂·6H₂O <i>v.</i> Co sulfate. K₂Co₂(SO₄)₄·24H₂O <i>v.</i> Co sulfate. K₂Ni(SO₄)₂·6H₂O <i>v.</i> Ni sulfate. K₂Mn(SO₄)₂·4H₂O <i>v.</i> Mn sulfate. K₂Mn₂(SO₄)₄·24H₂O <i>v.</i> Mn sulfate.	LiHSO₄ , <i>acid lithium sulfate, lithium bisulfate</i> . Deliq., prismatic cryst.; sol. in water, with partial decomp.; M. P. 120°; sp. gr. 2.1.	NH₄HSO₄ , <i>acid ammonium sulfate, ammonium bisulfate</i> . Long, deliq., rhombic prisms; sol. in water; very sl. sol. in alcohol; M. P. 147°; sp. gr. 1.8. (NH₄)₂Al₂(SO₄)₄·24H₂O <i>v.</i> Al sulfate. (NH₄)₂Cr₂(SO₄)₄·24H₂O <i>v.</i> Cr sulfate. (NH₄)₂Fe(SO₄)₂·6H₂O <i>v.</i> Fe(ous) sulfate. (NH₄)₂Fe₂(SO₄)₄·24H₂O <i>v.</i> Fe(ic) sulfate. (NH₄)₂Co(SO₄)₂·6H₂O <i>v.</i> Co sulfate. (NH₄)₂Co₂(SO₄)₄·24H₂O <i>v.</i> Co sulfate. (NH₄)₂Ni(SO₄)₂·6H₂O <i>v.</i> Ni sulfate. (NH₄)₂Mn(SO₄)₂·6H₂O <i>v.</i> Mn sulfate. (NH₄)₂Mn₂(SO₄)₄·24H₂O <i>v.</i> Mn sulfate. (NH₄)₂Zn(SO₄)₂·6H₂O <i>v.</i> Zn sulfate.

Sulfate
Cont.

Na, K, Li, NH₄ GROUP

	Sodium	Potassium	Lithium	Ammonium
Sulfate <i>Cont</i>		K ₂ Zn(SO ₄) ₂ ·6H ₂ O <i>v.</i> Zn sulfate. K ₂ Cu(SO ₄) ₂ ·6H ₂ O <i>v.</i> Cu(ic) sulfate.		(NH ₄) ₂ Pb(SO ₄) ₂ <i>v.</i> Pb sulfate. (NH ₄) ₂ Hg ₂ (SO ₄) ₄ · 2H ₂ O <i>v.</i> Hg sul- fate. (NH ₄) ₂ Cu(SO ₄) ₂ · 6H ₂ O <i>v.</i> Cu(ic) sulfate. (NH ₄) ₂ Cd(SO ₄) ₂ · 6H ₂ O <i>v.</i> Cd sulfate.
Sulfide	Na₂S, sodium sulfide, sodium monosulfide, soda sulfuret. Amorph., flesh-colored deliq., solid with a strongly alkaline reaction; turns yellow on standing in air, with formation of polysulfides; easily sol. in water to a clear soln. if pure; much less sol. in alcohol than in water; very easily decomp. by acids, even by CO₂, with evolution of H₂S; sp. gr. 1.8. Na₂S·9H₂O, hydrated sodium monosulfide. Transparent, colorless or reddish tetragonal cryst.; taste, hepatic at first, then alkaline and bitter; decomp. easily by CO₂; oxidizes to Na₂SO₄ on standing in air; sol. in water, with lowering of temp.; much less sol. in alcohol than in water. Several polysulfides are said to exist,—Na₂S₂, Na₂S₃, Na₂S₄ and Na₂S₅. Soda liver of sulfur is a brown solid, a mixture of Na polysulfides with other S compounds of Na.	K₂S, potassium sulfide, potassium monosulfide, potash sulfuret. Usually a flesh-colored to bright vermilion, cryst., deliq., solid; colorless, cryst. solid when pure; brown when impure; sol. in water, with production of much heat and formation of KSH and KOH; soln. is strongly alkaline and caustic, colorless at first, but rapidly turning yellow when exposed to air, H₂S being evolved; sol. in alcohol; volatilizes at red heat; M. P. 471°; sp. gr. 1.8. K₂S·5H₂O, hydrated potassium monosulfide. Bright red, deliq., rhombic prisms; M. P. 60°. Several polysulfides are said to exist,—K₂S₂, K₂S₃, K₂S₄, K₂S₅; they are better known than the corresponding Na salts, and are sol. in water and alcohol; the aq. soln. is generally yellowish brown, the depth of color increasing with the amount of sulfur. Liver of sulfur, potash liver of sulfur; brown solid; a mixture of K polysulfides with other S compounds of K.	Li₂S, lithium sulfide, lithium monosulfide. Yellow mass; sol. in water and in alcohol; more sol. than LiOH; aq. soln. is generally yellow; sp. gr. 1.6. Some polysulfides probably exist.	(NH₄)₂S, ammonium sulfide, ammonium monosulfide. Generally found as a colorless, alkaline, aq. soln., probably purest when the odors of both NH₃ and H₂S are recognizable; the water-free compound is said to be white, lustrous cryst. that dissolve easily in water; the aq. soln. turns yellow rapidly on standing with formation of NH₄ polysulfides. Several polysulfides exist,—(NH₄)₂S₂, (NH₄)₂S₃, (NH₄)₂S₄ and (NH₄)₂S₅; they are all sol. in water; the soln. is clear, varying from yellow to dark brown, with the amount of S present; they are decomp. by dil. acids, with formation of H₂S, pptd. S and an NH₄ salt. Volatile liver of sulfur or fuming liquor of Boyle is a dark yellow, strongly fuming, strongly smelling, aq. soln. of NH₄ polysulfides.

Sodium	Potassium	Lithium	Ammonium	
Na₂SO₃·7H₂O, <i>sodium sulfite, normal sodium sulfite</i>. Colorless, monoclinic prisms; saline, sulfurous taste; alkaline reaction; efflor. and partially oxidizes in air; sol. in water, 14 g. in 100 g. of water at 0°, 26 g. at 20°, 50 g. at 40°; loses all its cryst. water at 150°, without melting; melts at higher temp., with decomp. to a yellow liquid; sp. gr. 1.5. Na₂SO₃, <i>anhydrous sodium sulfite</i>. White, amorph. powder; other properties the same as those of the hydrated salt. NaHSO₃, <i>acid sodium sulfite, sodium bisulfite, leucogen, antichlor</i>. Opaque prisms or granular powder; faint, sulfurous odor; disagreeable taste; acid reaction; sol. in water with some difficulty; less sol. than NaHCO₃ or Na₂SO₃·7H₂O; gives off SO₂ on standing in air; decomp. by heat to Na₂SO₄, S, SO₂ and H₂O.	K₂SO₃·2H₂O, <i>potassium sulfite, normal potassium sulfite</i>. Large, colorless, deliq., oblique, rhombic octahedra; strong, alkaline reaction; bitter taste; sol. in cold water, less sol. in hot; very sl. sol. in alcohol. K₂SO₃, <i>anhydrous potassium sulfite</i>. Small, colorless, deliq., hexagonal prisms; decomp. when heated above 450°; other properties the same as those of the hydrated salt. KHSO₃, <i>acid potassium sulfite, potassium bisulfite</i>. White, monoclinic, prismatic needles or cryst. masses; neutral reaction; sulfurous acid odor and taste; evolves SO₂ on standing; sol. in water; insol. in abs. alcohol; decomp at 190°.	Li₂SO₃·H₂O, <i>lithium sulfite, normal lithium sulfite</i>. Colorless, transparent, lustrous needles or white powder; oxidizes in moist air; sol. in water; sl. sol. in alcohol; loses its cryst. water when heated, and melts at dull, red heat to a transparent liquid. Unknown.	(NH₄)₂SO₃, <i>ammonium sulfite, normal ammonium sulfite</i>. Colorless, non-deliq., cryst. powder or white, monoclinic leaflets, which are not deliq., but oxidize gradually to the sulfate; acrid, sulfurous taste; strongly alkaline reaction; sol. in cold water, more sol. in hot, with evolution of NH₃; sl. sol. in abs. alcohol; when heated H₂O is given off, then NH₃, and the rest sublimes as the acid salt. NH₄HSO₃, <i>acid ammonium sulfite, ammonium bisulfite</i>. White, cryst. powder; sol. in water.	Sulfite
Na₂C₄H₄O₆·2H₂O, <i>sodium tartrate, normal sodium tartrate, sal tartar</i>. White needles or rhombic, monoclinic prisms or cryst. powder; sol. in cold water, very sol. in hot water; insol. in alcohol. NaHC₄H₄O₆·H₂O, <i>acid sodium tartrate, sodium bitartrate</i>. White, cryst. powder; sol. in water; insol. in alcohol. NaKC₄H₄O₆·4H₂O,	2K₂C₄H₄O₆·H₂O, <i>potassium tartrate, normal potassium tartrate, soluble tartar, neutral tartar, vegetable salt</i>. Colorless, transparent, monoclinic cryst.; sol. in water; very sl. sol. in hot alcohol. KHC₄H₄O₆, <i>acid potassium tartrate, potassium bitartrate, cream of tartar, argol, argal, crude tartar, red argol, white argol, cream</i>. Colorless	Li C₄H₄O₆·H₂O, <i>lithium tartrate, normal lithium tartrate</i>. Small, white, deliq. cryst.; sol. in water. 2LiHC₄H₄O₆·3H₂O, <i>acid lithium tartrate, lithium bitartrate</i>. Small cryst.; very sol. in water.	(NH₄)₂C₄H₄O₆, <i>ammonium tartrate, normal ammonium tartrate</i>. Clear, colorless, efflor., monoclinic cryst.; very sol. in water; gives off NH₃ in air. NH₄HC₄H₄O₆, <i>acid ammonium tartrate, ammonium bitartrate</i>. Minute laminae or white, cryst., acid powder; sl. sol. in cold water.	Tartrate

Na, K, Li, NH. GROUP

	Sodium	Potassium	Lithium	Ammonium
Tartrate Cont.	<i>sodium potassium tartrate, Rochelle salt, Seignette salt, tartrated soda.</i> White, cryst. powder or large, nearly transparent, tri-metric prisms, with hemihedral facets; bitter taste; sol. in water; melts at 70° to 80° in its cryst. water; becomes anhydrous at 215°.	or sl. opaque, tri-metric cryst. or cryst. powder; pleasant acid taste; sparingly sol. in water; insol. in alcohol. $K(SbO)C_4H_4O_6$, <i>tartar emetic v. Sb tartrate.</i>		
Thio- cyanate	NaSCN , <i>sodium thiocyanate, sodium sulfocyanide, sodium sulfocyanate.</i> Clear, colorless, very deliq., rhombic plates or white powder; very sol. in water or alcohol; M. P. 562°.	KSCN , <i>potassium thiocyanate, potassium sulfocyanide, potassium sulfocyanate.</i> Long, white, striated prisms resembling niter; sometimes colorless scales; very sol. in water, with lowering of temp., 177 g. in 100 g. of water at 0°, 217 g. at 20°; sol. in alcohol; melts at 161°, the fluid salt turning brown at first, then green, finally indigo blue, but returning to a white solid on cooling.	LiSCN , <i>lithium thiocyanate, lithium sulfocyanide, lithium sulfocyanate.</i> White, very deliq., tabular cryst.; sol. in water or alcohol.	NH₄SCN , <i>ammonium thiocyanate, ammonium sulfocyanide, ammonium sulfocyanate.</i> Large, colorless or grayish white, very deliq., cryst. plates or leaflets; easily sol. in water, with lowering of temp.; easily sol. in alcohol; M. P. 159°; decomp. at 180° to 190°.
Thio- sulfate	Na₂S₂O₃·5H₂O , <i>sodium thiosulfate, sodium hyposulfite, "Hypo," antichlor.</i> Large, white or transparent, monoclinic prisms or fine, long needles; cooling, alkaline, somewhat sulfurous taste, with bitter aftertaste; neutral reaction; sol. in water, with lowering of temp., 60 g. of the anhydrous salt in 100 g. of water at 10°, 70 g. at 20°, 130 g. at 30°; insol. in alcohol; efflor. at 33°; melts at 48° in its cryst. water; decomp. at 220°; sp. gr. 1.7.	3K₂S₂O₃·H₂O , <i>potassium thiosulfate, potassium hyposulfite.</i> Large, thin, transparent, four-sided, monoclinic, prismatic cryst.; cooling taste, with bitter after-taste; very deliq.; very sol. in water, with absorption of heat; insol. in alcohol; loses all its cryst. water at c. 200°.	Li₂S₂O₃·3H₂O , <i>lithium thiosulfate, lithium hyposulfite.</i> Colorless, very deliq. cryst.; sol. in water or abs. alcohol; loses its cryst. water when heated, and decomp. at higher temp.	(NH₄)₂S₂O₃ , <i>ammonium thiosulfate, ammonium hyposulfite.</i> Very deliq., prismatic cryst.; sol. in water; insol. in alcohol; decomp. at 150°.
Tungstate	Na₂WO₄·2H₂O , <i>sodium tungstate, so-</i>	K₂WO₄ , <i>potassium tungstate, potas-</i>	Li₂WO₄ , <i>lithium tungstate, lithium</i>	(NH₄)₂WO₄ , <i>ammonium tungstate,</i>

Sodium	Potassium	Lithium	Ammonium
<i>dium orthotungstate, sodium wolframate, saffron bronze, gold bronze.</i> Colorless, transparent, thin, rhombic prisms or tablets; bitter taste; efflor. in dry air; loses all its cryst. water at 100°; sol. in water, 36 g. in 100 g. of water at 0°, 42 g. at 18°, 49 g. at 100°; insol. in alcohol; sp. gr. 3.2.	<i>sium orthotungstate, potassium wolframate.</i> White, deliq., triclinic needles; decrepitate when heated; melts at red heat; easily sol. in water; insol. in alcohol.	<i>orthotungstate, lithium wolframate.</i> Rhombic prisms or octahedra; alkaline reaction; sol. in water.	<i>ammonium orthotungstate, ammonium wolframate.</i> Known only in soln. $(\text{NH}_4)_x\text{W}_7\text{O}_{22}$, ordinary ammonium tungstate. Fine, white, needles or cryst. powder of variable composition; sol. in water.

Tungstate
Cont.

GROUP II

Barium	Ba
Strontium	Sr
Calcium	Ca
Magnesium	Mg

The four metals of this group are bivalent, grayish, of medium hardness, and heavier than water; the first three decompose water slowly at ordinary temperatures, with evolution of hydrogen and formation of difficultly soluble hydroxides of strong alkaline reaction; for this reason they are often spoken of as the alkaline-earth metals; Mg decomposes water only very slowly. The common oxides have the general formula $M'O$ and react with water to form the hydroxides. Peroxides of the general formula $M'O_2$ are known; on treatment with acids they yield hydrogen peroxide and the salt of the metal that corresponds with the acid used. The salts of these metals are generally colorless crystals or white powders. Most of the salts are insoluble in water; those soluble in water are the halogen compounds, the nitrites, nitrates, chlorates and acetates of the four metals, together with the sulfate of Mg; the other salts are generally insoluble. The halogen salts only are volatile; they impart characteristic colors to the Bunsen flame.—Ba yellowish green, Sr red, Ca orange. Other salts of these metals also give the flame coloration but not so prominently. The carbonates are decomposed by heat into CO_2 and the oxide of the metal. At times Mg acts as if it did not belong to this group; the other three members are noted for the similarity of their compounds and for a remarkable gradation of properties that is well illustrated by the absolute insolubility of barium sulfate, the slight solubility of strontium sulfate and the appreciable solubility of calcium sulfate.

Ba, Sr, Ca, Mg GROUP

	Barium	Strontium	Calcium	Magnesium
Metal	Ba, barium. Probably never obtained pure; said to be a yellow powder or a yellow, sl. lustrous, somewhat malleable, somewhat metallic element; oxidizes easily in air; decomp. cold water, with evolution of H_2; fusible Ba salts color the Bunsen flame yellowish green. At. No. 56; At. Wt. 137.37; Mol. Wt. unknown; val. 2; sp. gr. 3.5; melts at red heat, higher than cast iron, but cannot be distilled; burns in the oxyhydrogen flame; M. P. 850°; B. P. 1140°; 1 isotope.	Sr, strontium. Probably never obtained pure; said to be a yellowish white, malleable, ductile, metallic element; somewhat harder than Ca or Pb; can be beaten into thin leaves; oxidizes easily on exposure to air; decomp. cold water, with evolution of H_2; fusible Sr salts color the Bunsen flame red, somewhat similar to the Li red. At. No. 38; At. Wt. 87.62; Mol. Wt. unknown; val. 2; sp. gr. 2.6; melts at red heat; volatile only at extremely high temp.; M. P. 800°; B. P. 1150°; 2 isotopes.	Ca, calcium. Better known than Ba or Sr; lustrous, clear, yellowish white, malleable, ductile, metallic element; brittle when hammered out; generally small lumps; dark gray on the outside, lustrous yellow or gray on the inside; oxidizes easily; decomp. water, with evolution of H_2; fusible Ca salts color the Bunsen flame orange. At. No. 20; At. Wt. 40.07; Mol. Wt. unknown; val. 2; sp. gr. 1.55; melts at red heat, and then burns with a yellow flame; M. P. 810°; B. P. 1170°; 2 isotopes.	Mg, magnesium. Silver-white, very lustrous, ductile, malleable, not very tenacious, moderately hard metal in lumps, ribbon, wire or powder; occasionally has some cryst. structure; unchanged in dry air; oxidizes superficially, very slowly in ordinary air; when heated it burns with an intense white light; insol. in water, and does not decomp. it at ordinary temp., but forms $MgO \cdot H_2$ slowly at higher temp.; sol. in dil. acids, with evolution of H_2; not acted upon by alkaline hydroxide solns. At. No. 12; At. Wt. 24.32; Mol. Wt. probably the same; val. 2; sp. gr. 1.74; M. P. 651°; B. P. 1110°; 3 isotopes.
Acetate	Ba $(C_2H_3O_2)_2 \cdot 2H_2O$, <i>barium acetate</i>. White, flattened or monoclinic prisms; very easily sol. in water, 58 g. in 100 g. of water at 0°, 72 g. at 21°, 74 g. at 99°; insol. in alcohol; the anhydrous salt is a white powder; sp. gr. 2.2. BaH $(C_2H_3O_2)_3$, <i>acid barium acetate</i>. (?)	2Sr $(C_2H_3O_2)_2 \cdot H_2O$, <i>strontium acetate</i>. White, cryst. powder; sol. in water. SrH $(C_2H_3O_2)_3$, <i>acid strontium acetate</i>. (?)	Ca $(C_2H_3O_2)_2 \cdot H_2O$, <i>calcium acetate</i>, <i>vinegar salts</i>, <i>brown acetate</i>, <i>pyrolignite of lime</i>. Small, efflor. needles or white, amorph. powder; very sol. in water, 37 g. of the anhydrous salt in 100 g. of water at 0°, 35 g. at 20°, 30 g. at 100°; sl. sol. in alcohol. CaH $(C_2H_3O_2)_3$, <i>acid calcium acetate</i>. (?)	Mg $(C_2H_3O_2)_2 \cdot 4H_2O$, <i>magnesium acetate</i>, <i>sinodor</i>. Deliq., white granules or monoclinic cryst.; very sol. in water and in alcohol; sp. gr. 1.4. Unknown.
Arsenate	Ba₂ $(AsO_4)_3$, <i>barium arsenate</i>, <i>normal barium arsenate</i>, <i>barium arsenate</i>. White powder; insol. in water; sol. in dil. HCl, HNO_3 and $HC_2H_3O_2$.	Sr₂ $(AsO_4)_3$, <i>strontium arsenate</i>, <i>normal strontium arsenate</i>, <i>strontium arsenate</i>. Insol. in water; easily sol. in dil. acids.	Ca₃ $(AsO_4)_2 \cdot 3H_2O$, <i>calcium arsenate</i>, <i>normal calcium arsenate</i>, <i>calcium arsenate</i>. White powder or fine, white prisms; insol. in water; sol. in dil. HCl, HNO_3, $HC_2H_3O_2$ and $H_2AsO_4 + Aq$.	Mg₃ $(AsO_4)_2$, <i>magnesium arsenate</i>, <i>normal magnesium arsenate</i>, <i>magnesium arsenate</i>. White powder; insol. in water.

Barium	Strontium	Calcium	Magnesium	
$2\text{BaHAsO}_4 \cdot 3\text{H}_2\text{O}$, acid barium arsenate. Cryst.; very sl. sol. in water, but decomp. thereby into $\text{Ba}_3(\text{AsO}_4)_2$ and $\text{BaH}_2(\text{AsO}_4)_2$; sl. sol. in cold acids.	$2\text{SrHAsO}_4 \cdot 3\text{H}_2\text{O}$, acid strontium arsenate. Insol. in cold, but decomp. by hot water.	$2\text{CaHAsO}_4 \cdot \text{H}_2\text{O}$, acid calcium arsenate. Cryst.; insol. in water.	$\text{MgHAsO}_4 \cdot 5\text{H}_2\text{O}$, acid magnesium arsenate. Colorless cryst.; insol. in water.	Arsenate Cont.
$\text{Ba}(\text{AsO}_2)_2$, barium arsenite. White powder; gelatinous and easily sol. in water when freshly pptd.; granular and insol. in water when dry; sol. in dil. HCl , HNO_3 and $\text{HC}_2\text{H}_3\text{O}_2$; sl. sol. in $\text{H}_3\text{AsO}_4 + \text{Aq}$.	$\text{Sr}(\text{AsO}_2)_2 \cdot 4\text{H}_2\text{O}$, strontium arsenite. White, cryst. powder; quite easily sol. in water; sl. sol. in $\text{H}_3\text{AsO}_4 + \text{Aq}$; very sl. sol. in alcohol.	$\text{Ca}_2(\text{AsO}_2)_2$ (?), calcium arsenite. White, granular powder of variable composition; insol. in water; sol. in dil. HCl , HNO_3 and $\text{HC}_2\text{H}_3\text{O}_2$.	MgHAsO_3 (?), magnesium ammonium arsenite. Small cryst.; sl. sol. in water; sl. sol. in acids.	Arsenite
$\text{BaB}_2\text{O}_4 \cdot 10\text{H}_2\text{O}$, barium borate, barium metaborate. White, light masses; sl. sol. in cold, more readily in hot water, especially in the presence of NH_4 salts; insol. in wood alcohol.	SrB_2O_4, strontium borate, strontium metaborate. Short, thick cryst.; M. P. 1100° .	$\text{CaB}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$, calcium borate, calcium metaborate, colmanite, borate spar. Very light, white powder or needles; sl. sol. in water; sol. in $\text{CaCl}_2 + \text{Aq}$; also in cold or hot solns. of NH_4 salts, especially NH_4NO_3 ; easily sol. in dil. mineral acids; insol. in $\text{HC}_2\text{H}_3\text{O}_2$.	$\text{MgB}_2\text{O}_4 \cdot 8\text{H}_2\text{O}$, magnesium borate, magnesium metaborate. Fine, colorless, microscopic needle cryst.; insol. in hot or cold water; easily sol. in dil. HCl ; decomp. by concd. HCl .	Borate
BaB_4O_7, barium tetraborate. Insol. in water; slowly sol. in warm dil. HNO_3 .	SrB_4O_7, strontium tetraborate. Sl. sol. in water; sol. in cold, dil. HNO_3 ; easily sol. in solns. of NH_4 salts; M. P. 930° .	CaB_4O_7, calcium tetraborate. Decomp. by water.	$\text{MgB}_4\text{O}_7 \cdot 8\text{H}_2\text{O}$, magnesium tetraborate. Of doubtful existence.	
$\text{Ba}(\text{BrO}_3)_2 \cdot \text{H}_2\text{O}$, barium bromate. White, cryst. powder or colorless, prismatic, monoclinic cryst.; sl. sol. in cold water; sol. in hot water, 0.3 g. in 100 g. of soln. at 0° , 0.6 g. at 20° , 5.4 g. at 100° ; decomp. by HCl or H_2SO_4 ; loses its cryst. water at c. 200° ; de-	$\text{Sr}(\text{BrO}_3)_2 \cdot \text{H}_2\text{O}$, strontium bromate. Small, colorless, lustrous, very hygroscopic, monoclinic, prismatic cryst.; sol. in water, less so than SrBr_2 , 31 g. in 100 g. of soln. at 18° ; loses its cryst. water at c. 120° ; decomp. at 240° ; evolving some O_2 ;	$\text{Ca}(\text{BrO}_3)_2 \cdot \text{H}_2\text{O}$, calcium bromate. Colorless, monoclinic, prismatic cryst. or plates; sol. in water; loses its cryst. water at 180° ; decomp. at higher temp., giving O_2 and CaBr_2 ; sp. gr. 3.3.	$\text{Mg}(\text{BrO}_3)_2 \cdot 6\text{H}_2\text{O}$, magnesium bromate. Large, colorless, efflor., octahedral cryst.; melts in its cryst. water, which it loses above 200° ; decomp. when heated to a higher temp.; sol. in water, 42 g. in 100 g. of soln. at 18° .	Bromate

Ba, Sr, Ca, Mg GROUP

	Barium	Strontium	Calcium	Magnesium
Bromate <i>Cont.</i>	comp. at c. 260°, evolving O ₂ ; sp. gr. 3.9.	sp. gr. 3.8.		
Bromide	BaBr₂·2H₂O , <i>barium bromide</i> . Colorless or white, rhombic, trimetric plates or cryst. tablets; permanent in air; sol. in water, 98 g. of the anhydrous salt in 100 g. of water at 0°, 104 g. at 20°, 149 g. at 100°; very sol. in abs. alcohol; loses one H ₂ O at 75°, the other at 100°, and decomp. at higher temp.; sp. gr. 3.6.	SrBr₂·6H₂O , <i>strontium bromide</i> . Long, deliq., colorless or white needles; bitter, saline taste; sol. in water, 85 g. of the anhydrous salt in 100 g. of water at 0°, 102 g. at 20°, 222 g. at 100°; sl. sol. in abs. alcohol; melts in its cryst. water; absorbs NH ₃ ; decomp. at 20°; sp. gr. 2.3. SrBr₂ , <i>anhydrous strontium bromide</i> . White or colorless, hygroscopic powder; sol. in water; melts without decomp. when heated; M. P. 643°; sp. gr. 4.2.	CaBr₂ , <i>calcium bromide</i> . White, very deliq. lumps or needles; silky luster; sharp, saline taste; very sol. in water, 125 g. in 100 g. of water at 0°, 143 g. at 20°, 295 g. at 80°; sol. in alcohol; absorbs NH ₃ ; M. P. 765°; sp. gr. 3.3.	MgBr₂·6H₂O , <i>magnesium bromide</i> . Colorless, very deliq. cryst.; bitter taste; sol. in water, 92 g. of the anhydrous salt in 100 g. of water at 0°, 96 g. at 20°, 120 g. at 100°; the water soln. when heated to dryness yields MgO and HBr. MgBr₂ , <i>anhydrous magnesium bromide</i> . White, very deliq., wax-like, cryst. masses; sol. in water or alcohol; M. P. 700°; sp. gr. 3.7.
Carbide	BaC₂ , <i>barium carbide</i> . Black cryst.; resembles CaC ₂ closely; decomp. by water, giving C ₂ H ₂ and Ba(OH) ₂ ; easily decomp. by dil. acids; non-volatile; inflames in F ₂ ; sp. gr. 3.75.	SrC₂ , <i>strontium carbide</i> . Solid; easily decomp. by water, giving C ₂ H ₂ and Sr(OH) ₂ ; easily decomp. by dil. acids; non-volatile; inflames in F ₂ ; sp. gr. 3.2.	CaC₂ , <i>calcium carbide</i> . White, or colorless and transparent cryst. when pure; non-volatile; attacked by Br ₂ , Cl ₂ , and I ₂ ; inflames in F ₂ ; melts above Pt, probably 2300° to a very viscous liquid; probably decomp. at high temp.; decomp. by water, yielding C ₂ H ₂ and Ca(OH) ₂ ; readily decomp. by dil. acids; insol. in fuming HNO ₃ and concd. H ₂ SO ₄ ; insol. in cold HCl; not acted on by cold strong mineral acids; sol. in cold glacial acetic acid; sol. in fused alkali; fused CaC ₂ dissolves C which separates as graphite on cooling; reduces metallic oxides and dry chlorides energetically; sp. gr. 2.22.	MgC₂ , <i>magnesium carbide</i> . Solid that reacts with water giving C ₂ H ₂ and Mg(OH) ₂ . MgC₂ , <i>magnesium carbide</i> . Said to exist.

Barium	Strontium	Calcium	Magnesium
		<i>Commercial</i> CaC_2 (80-90% pure) is grayish yellow, grayish black, black, reddish black, or reddish brown solid; chief impurities are the sulfide, phosphide and silicide of Ca, the silicides of C and Fe, and graphite; reacts with water as does the pure CaC_2 .	
BaCO_3 , <i>barium carbonate, with-erite</i> . Colorless or white, rhombic cryst. or white, amorph. powder or soft, white, friable lumps; insol. in water; sl. sol. in $\text{NH}_4\text{Cl} + \text{Aq}$; sol. in $\text{NH}_4\text{NO}_3 + \text{Aq}$ or $\text{H}_2\text{CO}_3 + \text{Aq}$; easily sol. in dil. HCl , HNO_3 or $\text{HC}_2\text{H}_3\text{O}_2$, with evolution of CO_2 ; M. P. 1740° at 90 atmospheres; sp. gr. 4.4.	SrCO_3 , <i>strontium carbonate, strontianite</i> . Colorless or white, trimetric, rhombic cryst. resembling hexagonal pyramids; or white, very fine, amorph. powder; insol. in water; sl. sol. in $\text{NH}_4\text{Cl} + \text{Aq}$; sol. in $\text{NH}_4\text{NO}_3 + \text{Aq}$ and $\text{H}_2\text{CO}_3 + \text{Aq}$; sol. in dil. HCl , HNO_3 and $\text{HC}_2\text{H}_3\text{O}_2$, with evolution of CO_2 ; M. P. 1497° at 60 atmospheres; sp. gr. 3.7; begins to decomp. at 820° , losing CO_2 slowly at 1100° , but rapidly and more completely at white heat.	CaCO_3 , <i>calcium carbonate, calcite, calcspar, aragonite, Iceland spar, marble, limestone, chalk, precipitated calcium carbonate, precipitated chalk, dog-tooth spar, marl, nicolsonite, stalactite, stalagmite, travertine, tufa, bath stone, prepared chalk, English white, Paris white, rubbermaker's white, Spanish whiting, whiting, calcium white, mild lime, rock meal</i> . Native cryst. CaCO_3 varies from thin, tabular to long prismatic cryst. and from transparent to opaque; calcspar is generally colorless, hexagonal rhombohedra; aragonite, colorless, trimetric, right rhombic prisms; marble, massive and cryst.; chalk and pptd. CaCO_3 , fine, white or gray, amorph. lumps or powder; insol. in water; sl. sol. in $\text{NH}_4\text{Cl} + \text{Aq}$; sol. in $\text{H}_2\text{CO}_3 + \text{Aq}$; sol. in dil. HCl , HNO_3 and $\text{HC}_2\text{H}_3\text{O}_2$, with evolution of CO_2 ; similarly decomp. by H_2SO_4 , but leaving insol.	MgCO_3 , <i>magnesium carbonate, magnesite</i> . Very small, white cryst.; insol. in water, but slowly sol. in acids. $4\text{MgCO}_3 \cdot \text{MgO} \cdot \text{H}_2\text{O}$, <i>basic magnesium carbonate, precipitated magnesium carbonate, magnesite, magnesite alba</i> . Very light, fine, white, amorph. powder or lumps of variable composition; sl. earthy taste; sl. alkaline reaction; very friable; insol. in water; sol. in carbonic acid water; very easily sol. in acids, with evolution of CO_2 ; decomp. at 300° into MgO and CO_2 .

Carbide
Cont.

Carbonate

Ba, Sr, Ca, Mg GROUP

Carbonate
Cont.

Ba(HCO₃)₂ (?),
acid barium carbonate. Known only
in soln. in H₂CO₃
+ Aq.

Sr(HCO₃)₂ (?),
acid strontium carbonate. Known
only in soln. in
H₂CO₃ + Aq.

CaSO₄; decomp. at
full red heat into
CaO and CO₂; M.
P. 1339° at 10 at-
mospheres; sp. gr.
2.7.
Ca(HCO₃)₂ (?),
acid calcium carbonate. Known
only in soln. in
H₂CO₃ + Aq.

Mg(HCO₃)₂ (?),
acid magnesium carbonate. Known
only in soln. in
H₂CO₃ + Aq.

Chlorate

Ba(ClO₃)₂·H₂O,
barium chlorate.
Four-sided plates
or colorless, mono-
clinic prisms or
white powder; sol.
in cold water, more
in hot, 17 g. of the
anhydrous salt in
100 g. of soln. at
0°, 25 g. at 20°, 52
g. at 100°; only sl.
sol. in abs. alcohol;
decomp. when
heated to 120°,
giving O₂ at c.
250°, then a little
Cl₂, and melts at
c. 400°; sp. gr. 3.2.

Sr(ClO₃)₂·3H₂O,
strontium chlorate.
Four-sided deliq.,
rhombic prisms;
sol. in water; insol.
in alcohol; melts
with decomp.
above 290°. **Sr(ClO₃)₂**, *anhy-
drous strontium
chlorate*. Clear,
colorless, deliq.,
rhombic, pyra-
midal cryst.; sol.
in water; decomp.
when heated to
120° with evolu-
tion of O₂; sp. gr.
3.1.

Ca(ClO₃)₂·2H₂O,
calcium chlorate.
Very deliq., color-
less, rhombic
prisms; very sol. in
water, 64 g. of the
anhydrous salt in
100 g. of saturated
soln. at 18°; easily
sol. in alcohol; de-
comp. with evolu-
tion of O₂ when
heated slowly;
melts at c. 100° in
its cryst. water
when heated rap-
idly.

Mg(ClO₃)₂·6H₂O,
*magnesium chlo-
rate*. Very deliq.,
tabular cryst. or
white powder; bit-
ter taste; very eas-
ily sol. in water, 53
g. of anhydrous
salt in 100 g. of
soln. at 0°, 56 g. at
18°, 70 g. at 68°;
very easily sol. in
alcohol; decomp.
by heat at 120°
into O₂, Cl₂, H₂O
and MgO; M. P.
35°; sp. gr. 1.8.

Chloride

BaCl₂·2H₂O,
barium chloride.
Colorless, flat,
four-sided, mono-
clinic cryst. or
white powder; sta-
ble in air; bitter,
saline taste; sol. in
water, 32 g. in 100
g. of water at 0°,
36 g. at 20°, 59 g.
at 100°; sl. sol. in
alcohol; when
heated it loses its
cryst. water with-
out melting; sp.
gr. 3. **BaCl₂**, *anhydrous
barium chloride*.
White, amorph.
powder that melts
at 925°(?); sp. gr.
3.8.

SrCl₂·6H₂O, *stron-
tium chloride*.
White, hexagonal
needles or powder;
sharp, bitter taste;
sol. in water, 43 g.
of the anhydrous
salt in 100 g. of
water at 0°, 53 g.
at 20°, 100 g. at
100°; insol. in al-
cohol; decomp. at
61°; sp. gr. 1.9. **SrCl₂·2H₂O**, *stron-
tium chloride*. Col-
orless, rectangular
tablets or white,
cryst. powder with
a sharp, bitter
taste; sol. in wa-
ter; insol. in abs.
alcohol; melts in
its cryst. water at
112°, then at 825°
changes to a glass-
like mass, with an
alkaline reaction. **SrCl₂**, *anhydrous
strontium chloride*.
White powder; M.
P. 873°; sp. gr. 3.

CaCl₂·6H₂O, *cal-
cium chloride*,
freezing salts. Col-
orless, very deliq.,
hexagonal, pris-
matic cryst.; very
sol. in water; M.
P. 29.92°; B. P.
723°; sp. gr. 1.7. **CaCl₂**, *anhydrous
calcium chloride*,
hydropyrite,
*Homborg's phos-
phorus*. White,
deliq., fibrous
masses or dull
lumps; the fused
salt has cryst.
structure and alka-
line reaction; very
sol. in water, 59 g.
in 100 g. of water
at 0°, 74 g. at 20°,
159 g. at 100°;
very sol. in alco-
hol; M. P. 772°;
sp. gr. 2.1.

MgCl₂·6H₂O, *mag-
nesium chloride*,
bischofite. Colorless
or white, deliq.,
prismatic or chunk-
y, monoclinic
cryst.; sharp, bit-
ter taste; sol. in
water, 53 g. of the
anhydrous salt in
100 g. of water at
0°, 54 g. at 20°, 73
g. at 100°; sol. in
alcohol; becomes
entirely fluid at
118°, but loses
some HCl at 105°;
cannot be recryst.
from water soln.
because an aq.
soln. of MgCl₂
when heated, gives
HCl + MgO; sp.
gr. 1.5. **MgCl₂**, *anhydrous
magnesium chlo-
ride*, *chloromag-
nesite*. Large, flex-
ible, very deliq.,
tabular cryst. or
cryst. masses;
pearly luster;
sharp, bitter taste;
sol. in water or al-

Ba, Sr, Ca, Mg GROUP

Barium	Strontium	Calcium	Magnesium	Chloride Cont.
			cohol; distills at red heat in stream of H_2 ; M. P. 712° ; sp. gr. 2.3.	
BaCrO₄ , barium chromate, lemon chrome, barium yellow, chrome yellow, lemon yellow, pale lemon yellow, ultramarine yellow, yellow ultramarine, yellow chrome, permanent yellow. Heavy, yellow cryst. powder or small, rhombic cryst.; insol. in water; sol. in HCl, HNO_3 and $H_2CrO_4 + Aq$; insol. in $HCl \cdot H_2O_2$; sp. gr. 4.5.	SrCrO₄ , strontium chromate, strontium yellow, yellow ultramarine. Bright yellow powder or microscopic needles; nearly insol. in water; but sol. in HCl, HNO_3 , $HCl \cdot H_2O_2$ and $H_2CrO_4 + Aq$; sp. gr. 3.9.	CaCrO₄ · 2H₂O , calcium chromate, lime chrome. Steinbuhl yellow, gelbin, yellow ultramarine. Fine, lemon-yellow powder or yellowish red, prismatic, microscopic cryst.; sl. sol. in water; easily sol. in $H_2CrO_4 + Aq$; insol. in abs. alcohol.	MgCrO₄ · 7H₂O , magnesium chromate. Orange-yellow, cryst. powder or large, transparent, yellow prisms; sol. in water; loses $6H_2O$ at 100° .	Chromate
BaCr₂O₇ · 2H₂O , barium bichromate, barium dichromate. Yellow needles or rhombic plates; decomp. by water to $BaCrO_4$; sol. in $H_2CrO_4 + Aq$.	SrCr₂O₇ · 3H₂O , strontium bichromate, strontium dichromate. Thick, brownish red, monoclinic tablets; sol. in water; loses its cryst. water at 260° and decomp. at higher temp. to $SrCrO_4$.	CaCr₂O₇ · 3H₂O , calcium bichromate, calcium dichromate. Small, red, very deliq. cryst.; sol. in water; loses its cryst. water when heated, and then melts to a brown liquid.	Unknown.	
Ba(CN)₂ , barium cyanide. White, lustrous, scaly cryst.; decomp. to $BaCO_3$ on standing in air; sparingly sol. in water, 8 g. in 100 g. of water, with partial decomp.; more easily sol. in $KCN + Aq$; decomp. by CO_2 , with formation of HCN.	Sr(CN)₂ , strontium cyanide. Unstable, very deliq. cryst. that are decomp. by CO_2 , with formation of HCN.	Ca(CN)₂ , calcium cyanide. Cubical cryst.; sol. in water; its aq. soln. decomp. when heated; easily decomp. by CO_2 , with formation of HCN.	Mg(CN)₂ , magnesium cyanide. Known only in aq. soln., which is a little more easily decomp. than $Ca(CN)_2$.	Cyanide
Ba₂Fe(CN)₆ · 6H₂O , barium ferrocyanide. Small, yellow, flat, four-sided, right-angled, monoclinic prisms; sl. sol. in cold water, more in hot; sol. in HNO_3 , HCl and concd. H_2SO_4 ; loses most of its cryst. water at 40° .	Sr₂Fe(CN)₆ · 15H₂O , strontium ferrocyanide. Yellow, monoclinic, hexagonal prisms or tabular cryst.; efflor., losing half its cryst. water on standing in air, the other half on the steam bath; easily sol. in water; sl. sol. in alcohol.	Ca₂Fe(CN)₆ · 12H₂O , calcium ferrocyanide. Pale yellow, oblique, triclinic prisms; very easily sol. in cold water; apparently less sol. in hot; loses nearly all its cryst. water at 40° .	Mg₂Fe(CN)₆ · 10H₂O , magnesium ferrocyanide. Small, pale yellow needles in star-like masses; stable in air; sol. in water.	Ferrocyanide

Ba, Sr, Ca, Mg GROUP

Ferri-
cyanide

Barium	Strontium	Calcium	Magnesium
$\text{Ba}_3[\text{Fe}(\text{CN})_6]_2 \cdot 20\text{H}_2\text{O}$, <i>barium ferricyanide</i> . Easily sol. in water; insol. in alcohol.	Unknown.	$\text{Ca}_3[\text{Fe}(\text{CN})_6]_2 \cdot 10\text{H}_2\text{O}$, <i>calcium ferricyanide</i> . Fine, reddish or orange-red, very deliq. needles; sol. in water or dil. alcohol.	$\text{Mg}_3[\text{Fe}(\text{CN})_6]_2$, <i>magnesium ferricyanide</i> . Red-brown, amorph. masses; sol. in water.

Fluoride

Barium	Strontium	Calcium	Magnesium
BaF_2 , <i>barium fluoride</i> . White, finely granular, cryst. powder; very sparingly sol. in water; less sol. than CaF_2 ; sol. in HCl , HNO_3 , $\text{HC}_2\text{H}_3\text{O}_2$ and HF ; does not decomp. when heated; M. P. 1280° ; sp. gr. 4.8.	SrF_2 , <i>strontium fluoride</i> . White, cryst. powder or regular, octahedral cryst.; very sparingly sol. in water and HF ; sol. in hot HCl ; sl. sol. in HNO_3 ; decomp. by hot H_2SO_4 ; M. P. 1190° ; sp. gr. 2.4.	CaF_2 , <i>calcium fluoride</i> , <i>fluorite</i> , <i>fluor-spar</i> , <i>fluor</i> , <i>Derbyshire spar</i> . White, or grayish white, fine powder; well formed cubes occur in nature; insol. in water; sol. in solns. of NH_4 salts; sol. in cold concd. HCl , HF , H_2SO_4 and HNO_3 , but repts. when the solns. are diluted; sol. in hot dil. HCl ; decomp. by hot H_2SO_4 , with evolution of HF ; the dry salt melts without decomp. at 1360° ; sp. gr. 3.2.	MgF_2 , <i>magnesium fluoride</i> , <i>sellaite</i> . White, tasteless, amorph. powder or long, thin, four-sided, very hard needles; insol. in water; sl. sol. in acids; insol. in HF ; M. P. 1396° ; sp. gr. 3.

Hydride

Barium	Strontium	Calcium	Magnesium
BaH_2 , <i>barium hydride</i> . Gray cryst. masses; decomp. by water and dil. HCl ; burns slowly in air, rapidly in O_2 ; no solvent known; decomp. at 675° ; sp. gr. 4.21; M. P. 1200° ; B. P. 1100° .	SrH_2 , <i>strontium hydride</i> . White solid; decomp. by high heat; resembles CaC_2 ; decomp. by water and dil. HCl ; burns slowly in air; no solvent known.	CaH_2 , <i>calcium hydride</i> , <i>hydrone</i> . Fused masses of slender transparent plates when pure; gray powder when impure; burns brilliantly in air; attacked by S, P, and the halogens when heated; readily decomp. by water, evolving H_2 which often ignites from the heat evolved; decomp. by dil. acids; almost insol. in concd. acids; insol. in CS_2 and organic solvents; no solvent known; decomp. at 675° ; sp. gr. 1.7. CaH , <i>calcium hydride</i> . Decomp. by water.	MgH_2 , <i>magnesium hydride</i> . Of doubtful existence; if formed at all it probably decomp. before it can be isolated or studied.

Hydroxide

Barium	Strontium	Calcium	Magnesium
$\text{BaO} \cdot \text{H} \cdot 8\text{H}_2\text{O}$, <i>barium hydroxide</i> , <i>barium hydrate</i> , <i>caustic baryta</i> , <i>hydrated baryta</i> . White or colorless.	$\text{SrO} \cdot \text{H} \cdot 8\text{H}_2\text{O}$, <i>strontium hydroxide</i> , <i>strontium hydrate</i> , <i>hydrated strontia</i> . Small, transparent, color-	$\text{CaO} \cdot \text{H}_2$, <i>calcium hydroxide</i> , <i>calcium hydrate</i> , <i>caustic lime</i> , <i>slaked lime</i> , <i>lime</i> , <i>airslaked lime</i> , <i>hydrated</i>	$\text{MgO} \cdot \text{H}_2$, <i>magnesium hydroxide</i> , <i>magnesium hydrate</i> , <i>magnesia</i> , <i>brucite</i> . Found in nature as white,

Barium	Strontium	Calcium	Magnesium	Hydroxide Cont
quadratic tablets or white powder; absorbs CO_2 from the air, forming BaCO_3 ; somewhat sol. in water, 1.7 g. of the anhydrous hydroxide in 100 g. of water at 0° , 4 g. at 20° , 101 g. at 80° , with formation of a colorless, alkaline soln. called <i>baryta water</i> ; considerably more sol. than SrO_2H_2 ; sl. sol. in alcohol; readily sol. in cold $\text{NH}_4\text{Cl} + \text{Aq}$; the hydrated cryst. melts in its cryst. water at 77.9° , the amorph. form melts at red heat, and yields BaO and H_2O at higher temp.; sp. gr. of $\text{Ba}(\text{OH})_2$ is 4.5, of the hydrated compound 2.1.	less, deliq., quadratic cryst. or fine, white powder; sol. in water, forming an alkaline solution, 1 g. in 100 g. of soln. at 0° , 1.7 g. at 20° , 47 g. at 100° ; less sol. than BaO_2H_2 , more than CaO_2H_2 ; sol. in cold $\text{NH}_4\text{Cl} + \text{Aq}$; absorbs CO_2 from the air, forming SrCO_3 ; loses all its cryst. water at 100° , then melts at higher heat and finally yields SrO and H_2O ; sp. gr. 1.9.	<i>lime</i> . Generally found as white or grayish white, amorph. powder or lumps; rarely found as colorless, six-sided prisms or tablets; strong alkaline reaction; sl. sol. in water, 0.18 g. in 100 g. of water at 0° , 0.16 g. at 20° , 0.077 g. at 100° , forming colorless, alkaline soln., called <i>lime water</i> ; less sol. than SrO_2H_2 , more than MgO_2H_2 ; sol. in $\text{NH}_4\text{Cl} + \text{Aq}$; alcohol dissolves only traces; when moist it absorbs CO_2 from the air, forming CaCO_3 ; does not melt, but yields CaO and H_2O at bright red heat; sp. gr. 2.3.	pearly, cryst, hexagonal tablets; ordinarily a light, white powder; sometimes pasty, somewhat cryst. masses that absorb CO_2 from the air; almost insol. in water, with feebly alkaline reaction; sol. in solns. of NH_4 salts, notably $\text{NH}_4\text{Cl} + \text{Aq}$; easily sol. in dil. acids; yields MgO and H_2O when heated to low redness.	
$\text{Ba}(\text{OCl})_2$, <i>barium hypochlorite</i> . Known only in soln.; said to decomp. at 235° .	$\text{Sr}(\text{OCl})_2$, <i>strontium hypochlorite</i> . Known only in soln.	$\text{Ca}(\text{OCl})_2 \cdot 4\text{H}_2\text{O}$, <i>calcium hypochlorite, tetrahydrated hypochlorite</i> . Feathery cryst.; deliq.; sol. in water; decomp. when heated. CaClOCl , <i>calcium hypochlorite chloride, bleaching powder, chloride of lime, chlorinated lime</i> . Dry powder, white when pure, often grayish white; perhaps a mixture of $\text{Ca}(\text{OCl})_2$, CaCl_2 , $\text{Ca}(\text{OH})_2$ and H_2O ; characteristic odor, not like Cl_2 , however; sol. in 20 parts of water to an alkaline soln. probably containing $\text{Ca}(\text{OCl})_2$, CaCl_2 and $\text{Ca}(\text{OH})_2$; said to be not deliq. when pure; commercial form is usually deliq. and absorbs CO_2 from the air, becoming pasty	$\text{Mg}(\text{OCl})_2$, <i>magnesium hypochlorite</i> . Known only in soln. which changes to $\text{Mg}(\text{ClO}_3)_2$ at 70° .	Hypo-chlorite

Ba, Sr, Ca, Mg GROUP

Hypo-
chlorite
Cont.Hypo-
phos-
phite

Iodate

Iodide

Barium	Strontium	Calcium	Magnesium
		mass; decomp. a little in closed containers, more rapidly when exposed to air, heat, light or shaking; loses part of its active Cl on standing; all the Cl released by dil. acids; CO ₂ releases much of the Cl from the moist powder, but none from the dry.	
Ba(H ₂ PO ₃) ₂ ·H ₂ O, <i>barium hypophosphite</i> . White, monoclinic needles with mother-of-pearl luster; sol. in water; insol. in alcohol; efflor. in air; loses its cryst. water at 100°; decomp. at higher heat.	Sr(H ₂ PO ₃) ₂ , <i>strontium hypophosphite</i> . Tabular cryst.; stable in air; easily sol. in water; insol. in alcohol; decomp. when heated.	Ca(H ₂ PO ₃) ₂ , <i>calcium hypophosphite, hypophosphite of lime</i> . Small, lustrous scales or colorless, transparent, monoclinic cryst. or a white, cryst. powder; very bitter taste; stable in air; sol. in water; solubility not increased by heat; insol. in alkalies; insol. in strong, very sl. sol. in weak alcohol; decomp. at red heat.	Mg(H ₂ PO ₃) ₂ ·6H ₂ O, <i>magnesium hypophosphite</i> . Hard, lustrous cryst., sometimes octahedra and sometimes cubes; efflor. easily; sol. in water.
Ba(IO ₃) ₂ ·H ₂ O, <i>barium iodate</i> . Lustrous, monoclinic cryst. or white, cryst. powder; sol. in hot water; dissolves with difficulty in cold water and in warm HNO ₃ , but easily in cold HCl; insol. in H ₂ SO ₄ or alcohol; loses its cryst. water at 130°; sp. gr. 5.2.	Sr(IO ₃) ₂ ·6H ₂ O, <i>strontium iodate</i> . Cryst. powder; dissolves with difficulty in water and in warm, dil. HNO ₃ ; sp. gr. 5.	Ca(IO ₃) ₂ ·6H ₂ O, <i>calcium iodate</i> . Efflor., rhombic, microscopic prisms; very sl. sol. in hot water; more sol. in HNO ₃ ; insol. in H ₂ SO ₄ or alcohol; decomp. by HCl.	Mg(IO ₃) ₂ ·4H ₂ O, <i>magnesium iodate</i> . Well defined, monoclinic cryst.; high luster; sol. in water, 3 g. of the anhydrous salt in 100 g. of soln. at 0°, 10 g. at 20°, 19 g. at 100°; easily sol. in dil. H ₂ SO ₄ ; loses part of its cryst. water at 150°, the rest at 290°, and decomp. at higher heat into MgO, I ₂ and O ₂ ; sp. gr. 3.3.
BaI ₂ ·2H ₂ O, <i>barium iodide</i> . Small, deliq., colorless cryst.; decomp. and reddens on exposure; sol. in water or alcohol; when heated it melts in its cryst. water, then becomes water-free, and finally melts again at higher temp. BaI₂ , <i>anhydrous</i>	SrI ₂ ·6H ₂ O, <i>strontium iodide</i> . White or sl. yellow, finely cryst., deliq. powder or almost colorless hexagonal plates; saline, sl. bitter taste; sol. in water, 165 g. in 100 g. of water at 0°, 177 g. at 20°, 383 g. at 100°. SrI₂ , <i>anhydrous strontium iodide</i> .	CaI ₂ , <i>calcium iodide, calcidine</i> . Yellowish white, hygroscopic masses, white powder, or colorless tablets; absorbs CO ₂ and decomp. in air; very sol. in water or alcohol; M. P. 575°; sp. gr. 3.9.	MgI ₂ ·8H ₂ O, <i>magnesium iodide</i> . Cryst.; otherwise similar to the anhydrous salt. MgI₂ , <i>anhydrous magnesium iodide</i> . White, waxy solid or dark brown, cryst. powder; very deliq.; decomp. when dissolved in water; decomp. by heat

Barium	Strontium	Calcium	Magnesium	Iodide Cont.
<i>barium iodide.</i> White, non-deliq. powder or solid; easily sol. in water, 170 g. in 100 g. of water at 0°, 203 g. at 20°, 271 g. at 100°; easily sol. in alcohol; decomp. when heated to 740°; aq. soln. absorbs CO ₂ from the air; sp. gr. 5.1.	White solid; sol. in water; M. P. 402°; decomp. at higher temp.; sp. gr. 4.5.		into MgO and I ₂ ; sol. in alcohol; sp. gr. 4.2.	
BaMnO₄ , <i>barium manganate, Cas-sel's green, manga-nese green, Rosen-thiehl's green, ba-ryta green.</i> Fine, blue ppt. or emer-ald green powder, microscopic prisms or six-sided plates; stable in air; insol. in water; decomp. by acids.	SrMnO₄ , <i>strontium manganate.</i> Bluish green powder; in-sol. in water.	CaMnO₄ , <i>calcium manganate.</i> Of doubtful existence; said to be brown masses, insol. in water.	Unknown.	Manganate
Ba(MnO₄)₂ , <i>bari-um permanganate.</i> Large, orthorhom-bic needle cryst.; deep red, almost black in color, with violet reflection; sol. in water; sta-ble.	Sr(MnO₄)₂·4H₂O , <i>strontium perman-ganate.</i> Cryst. masses; deliq.; sol. in water.	Ca(MnO₄)₂·5H₂O , <i>calcium permanga-nate.</i> Deliq., brown cryst. or cryst. masses; vio-let luster; sol. in water.	Mg(MnO₄)₂·6H₂O , <i>magnesium per-manganate.</i> Very deliq. cryst.; sol. in water.	
BaMoO₄ , <i>barium molybdate.</i> White, cryst. powder; sparingly sol. in water; sol. with difficulty in most acids; sol. in dil. HCl or HNO ₃ ; sp. gr. 6.3.	SrMoO₄ , <i>strontium molybdate.</i> Micro-scopic pyramids or fine powder; insol. in water or HC ₂ H ₃ O ₂ ; sp. gr. 4.1.	CaMoO₄ , <i>calcium molybdate, powel-lite.</i> Microscopic pyramids or fine powder; insol. in water, HC ₂ H ₃ O ₂ or alcohol; sp. gr. 4.3.	MgMoO₄·5H₂O , <i>magnesium molyb-date.</i> Prismatic, lustrous cryst.; easily sol. in cold water, still more in hot; loses c. half its cryst. water at 100°; does not melt when heated.	Molybdate
Ba(NO₃)₂ , <i>barium nitrate, nitrobarite, baryta saltpeter.</i> Colorless, transpa-rent, lustrous, regu-lar, octahedral cryst. or white powder; somewhat hygroscopic; sol. in water, 5 g. in 100 g. of water at 0°, 9 g. at 20°, 34 g. at 100°; insol. in coned. HNO ₃ ; much less sol. in dil. HNO ₃ or HCl than in water, and still less sol. in dil.	Sr(NO₃)₂·4H₂O , <i>strontium nitrate.</i> Monoclinic cryst. that lose some cryst. water on standing and the rest at 100°; melts in its cryst. water when heated, and then decomp. like the anhydrous salt; sp. gr. 2.2. Sr(NO₃)₂ , <i>anhy-drous strontium ni-trate.</i> Colorless, octahedral cryst.; sol. in water, 40 g. in 100 g. of water	Ca(NO₃)₂·4H₂O , <i>calcium nitrate, Norwegian salt-pe-ter, Baldwin's phos-phorus.</i> Colorless, six-sided, mono-clinic cryst. or white to yellowish white, radiated, deliq., cryst. masses; very sol. in water, with evolution of much heat, 55 g. of the anhydrous salt in 100 g. of soln. at 18°; sol. in glacial HC ₂ H ₃ O ₂ ; insol. in	Mg(NO₃)₂·6H₂O , <i>magnesium nitrate.</i> White to yellowish white, rhombic, monoclinic prisms or needles; very deliq.; sharp, bitter taste; sol. in water, 40 g. of the anhydrous salt in 100 g. of water at 0°, 42 g. at 18°, 57 g. at 90°; melts in its cryst. water at 95°, the resulting liquid boiling at 144°, evolving HNO ₃ at higher	Nitrate

Ba, Sr, Ca, Mg GROUP

	Barium	Strontium	Calcium	Magnesium
Nitrate <i>Cont.</i>	$\text{HC}_2\text{H}_3\text{O}_2$; insol. in abs. alcohol; solubility in dil. alcohol increases with the temp.; M. P. 217° ; decomp. when heated; sp. gr. 3.2.	at 0° , 70 g. at 20° , 101 g. at 100° ; very sl. sol. in concd. HNO_3 or HCl ; nearly insol. in abs. alcohol; decomp. when heated, leaving SrO ; M. P. 570° ; sp. gr. 2.9.	HNO_3 ; nearly insol. in alcohol; melts at 42.7° ; boils at 132° , remaining clear until c. one-third of the cryst. water has gone, when the anhydrous salt is deposited. $\text{Ca}(\text{NO}_3)_2$, <i>anhydrous calcium nitrate</i> , <i>nitrocalcite</i> , <i>wall salt peter</i> . White powder; melts at 561° ; decomp. at higher temp., leaving phosphorescent mass; sp. gr. 1.8.	temp. and finally leaving MgO ; sp. gr. 1.4.
Nitrite	$\text{Ba}(\text{NO}_2)_2 \cdot 2\text{H}_2\text{O}$, <i>barium nitrite</i> . White, cryst. powder or colorless, hexagonal prisms or pyramids; stable in air; reaction neutral or sl. alkaline; very sol. in water, 58 g. in 100 g. of water at 0° , 63 g. at 20° , 97 g. at 35° ; sol. in dil. alcohol; insol. in abs. alcohol; sp. gr. 3.9.	$\text{Sr}(\text{NO}_2)_2 \cdot 2\text{H}_2\text{O}$, <i>strontium nitrite</i> . Stable, octahedral cryst.; sol. in water; decomp. when heated; sp. gr. 2.4. $\text{Sr}(\text{NO}_2)_2$, <i>anhydrous strontium nitrite</i> . White powder or hygroscopic needles; very sol. in water; sol. with difficulty in alkalies; sl. sol. in dil., insol. in abs. alcohol; sp. gr. 2.8.	$\text{Ca}(\text{NO}_2)_2 \cdot 2\text{H}_2\text{O}$, <i>calcium nitrite</i> . Yellowish masses or deliq. prisms; very sol. in water; sol. with difficulty in alkalies; insol. in dil. alcohol; sp. gr. 2.2.	$\text{Mg}(\text{NO}_2)_2 \cdot 2\text{H}_2\text{O}$, <i>magnesium nitrite</i> . Deliq., scaly masses; sol. in water; partially sol. in abs. alcohol; decomp. when heated dry to 100° or when boiled in soln.
Oxalate	$\text{BaC}_2\text{O}_4 \cdot \text{H}_2\text{O}$, <i>barium oxalate</i> . White powder, very sl. sol. in water; sol. in HCl , HNO_3 and $\text{HC}_2\text{H}_3\text{O}_2$. $\text{Ba}(\text{HC}_2\text{O}_4)_2 \cdot 2\text{H}_2\text{O}$, <i>acid barium oxalate</i> . White cryst.; sol. in water.	SrC_2O_4 , <i>strontium oxalate</i> . White, cryst. powder; sl. sol. in water. $\text{Sr}(\text{HC}_2\text{O}_4)_2 \cdot 2\text{H}_2\text{O}$, <i>acid strontium oxalate</i> . White cryst.	CaC_2O_4 , <i>calcium oxalate</i> . White, friable masses or very fine, amorph. powder; insol. in water; sol. in HCl or HNO_3 ; insol. in $\text{HC}_2\text{H}_3\text{O}_2$; sp. gr. 2.2.	$\text{MgC}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$, <i>magnesium oxalate</i> . White powder; sol. in water.
Oxide	BaO , <i>barium oxide</i> , <i>barium monoxide</i> , <i>baryta</i> , <i>calcined baryta</i> . Occasionally colorless, cubical cryst.; generally grayish white, porous, amorph. masses; combines with O_2 at c. 450° to form BaO_2 , which is again reduced to BaO at higher temp.; BaO finally melts at white heat; takes up H_2O	SrO , <i>strontium oxide</i> , <i>strontium monoxide</i> , <i>strontia</i> . Grayish white, porous, infusible, caustic masses; occasionally regular cubes; absorbs CO_2 from the air, with formation of SrCO_3 ; sol. in water, with evolution of heat and formation of alkaline soln. of SrO_2H_2 ; very sl. sol. in alcohol; M. P.	CaO , <i>calcium oxide</i> , <i>calcium monoxide</i> , <i>lime</i> , <i>quick lime</i> , <i>burnt lime</i> , <i>caustic lime</i> , <i>calc. fat lime</i> , <i>lean lime</i> (<i>impure</i>), <i>unslaked lime</i> . Occasionally lustrous cubes, generally hard, alkaline, infusible, white or grayish white lumps that gradually crumble on exposure to air; absorbs H_2O and CO_2 on standing;	MgO , <i>magnesium oxide</i> , <i>magnesia</i> , <i>burnt magnesia</i> , <i>magnesia usta</i> , <i>calcined magnesia</i> , <i>heavy magnesia</i> , <i>light magnesia</i> , <i>periclase</i> , <i>magnesia white</i> . Occasionally transparent, cubical cryst.; generally a very light, voluminous, fine, white powder; more or less flocculent, according to the temp. and

Barium	Strontium	Calcium	Magnesium	Oxide Cont.
and CO ₂ on standing in air; sol. in water with evolution of heat to form an alkaline soln. of BaO ₂ H ₂ ; easily sol. in dil. HNO ₃ or HCl; sol. with combination in abs. alcohol; with acids it forms the corresponding salts; M. P. 1923°; sp. gr. 5.7. BaO₂, barium dioxide, barium peroxide. Coarse, heavy, grayish white, amorph. powder; melts at full red heat, evolving O ₂ ; absorbs CO ₂ from the air, with formation of BaCO ₃ ; insol. in water; decomp. by boiling water; sol. in dil. acids, with formation of H ₂ O ₂ ; sp. gr. 4.9. BaO₂.8H₂O, hydrated barium peroxide. White powder or microscopic, cryst. scales with mother-of-pearl luster; very sl. sol. in water; alkaline reaction; decomp. when heated, losing half its cryst. water, then O ₂ .	2430°; sp. gr. 4.7. SrO₂, strontium dioxide, strontium peroxide. White powder; melts at red heat; sl. sol. in water; easily sol. in acids or NH ₄ Cl + Aq; insol. in NH ₄ OH. SrO₂.8H₂O, hydrated strontium peroxide. White powder or pearly scales; sol. with difficulty in water; insol. in NH ₄ OH; sol. in NH ₄ Cl + Aq or acids; changes to SrO ₂ at 100°.	decomp. by H ₂ O, evolving much heat and forming CaO ₂ H ₂ , which is sl. sol.; reacts with most acids to form salts; does not change to CaO ₂ when heated, but becomes incandescent (so-called <i>lime light</i>); M. P. 2572°; sp. gr. 3.4. CaO₂, calcium dioxide, calcium peroxide. Snow-white, cryst. powder; does not melt at red heat, but gives off O ₂ , and leaves CaO; very sl. sol. in water; easily sol. in acids or solns. of NH ₄ salts; insol. in NH ₄ OH. CaO₂.8H₂O, hydrated calcium peroxide. Colorless, efflor., prismatic, hexagonal cryst. or white powder; loses half its cryst. water at red heat; slowly sol. in water, with gradual decomp. to CaO ₂ H ₂ ; insol. in NH ₄ Cl + Aq or dil. acids, even in HC ₂ H ₃ O ₂ .	length of time it has been heated; sl. alkaline taste and reaction; absorbs H ₂ O and CO ₂ from the air slowly, forming MgCO ₃ .x MgO.H ₂ yH ₂ O (<i>v.</i> Mg carbonate); sl. sol. in water; easily sol. in dil. acids, even H ₂ SO ₄ and H ₂ CO ₃ ; sol. in solns. of NH ₄ salts; does not melt when heated, but gives out a very clear, white light; made into a paste with a little water, MgO sets up to a hard, white mass, but loses this setting up power when heated; M. P. 2800°; sp. gr. 3.6.	
Ba₃(PO₄)₂.H₂O, barium phosphate, normal barium phosphate, neutral barium phosphate, tribarium orthophosphate, tertiary barium phosphate. Heavy, white powder; insol. in water; sol. in HCl; decomp. by H ₂ SO ₄ .	Sr₃(PO₄)₂, strontium phosphate, normal strontium phosphate, neutral strontium phosphate, tristrontium orthophosphate, tertiary strontium phosphate. White powder, amorph. or cryst.; insol. in water; decomp. when boiled with water; sol. in HCl and H ₃ PO ₄ + Aq.	Ca₃(PO₄)₂, calcium phosphate, normal calcium phosphate, neutral calcium phosphate, tricalcium orthophosphate, tertiary calcium phosphate, precipitated phosphate. Light, white, odorless, tasteless, amorph. powder or masses; nearly insol. in cold water; slowly decomp. by boiling water into a basic phosphate; sol. in HCl, HNO ₃ , H ₃ PO ₄ , HC ₂ H ₃ O ₂ , H ₂ SO ₄ , and in solns. of NH ₄ salts; insol. in alcohol;	Mg₃(PO₄)₂.7H₂O, magnesium phosphate, normal magnesium phosphate, neutral magnesium phosphate, trimagnesium orthophosphate, tertiary magnesium phosphate. Heavy, white, tasteless, amorph. powder; insol. in water; easily sol. in acids, except HC ₂ H ₃ O ₂ .	Phosphate

Ba, Sr, Ca, Mg GROUP

Phosphate
Cont.

Barium	Strontium	Calcium	Magnesium
BaHPO₄, <i>barium phosphate, acid barium phosphate, dibarium orthophosphate, secondary barium phosphate, ordinary barium phosphate.</i> Pptd. from Ba solns. by Na₂HPO₄; fine, white, cryst. powder; insol. in water; sparingly sol. in HC₂H₃O₂; sol. in H₃PO₄ + Aq, HCl, HNO₃ and in solns. of NH₄ salts. Ba(H₂PO₄)₂, <i>barium phosphate, acid barium phosphate, monobarium orthophosphate, primary barium phosphate.</i> White, stable, triclinic cryst. with acid reaction; insol. in water; decomp. by much water into BaHPO₄; sol. in H₃PO₄ and some other acids. Ba(PO₃)₂, <i>barium metaphosphate, monobarium metaphosphate.</i> White powder; insol. in water and dil. acids; decomp. by concd. H₂SO₄. Ba₂P₂O₇·H₂O, <i>barium pyrophosphate.</i> White, amorph. powder; sparingly sol. in water; insol. in HC₂H₃O₂, Na₂P₂O₇ + Aq or NH₄Cl + Aq; sol. in H₃P₂O₇, HCl and	SrHPO₄, <i>strontium phosphate, acid strontium phosphate, distrontium orthophosphate, secondary strontium phosphate, ordinary strontium phosphate.</i> Pptd. from Sr solns. by Na₂HPO₄; white powder; insol. in water; sol. in HCl, HNO₃, H₃PO₄ + Aq, NH₄Cl + Aq, and NH₄NO₃ + Aq, but repptd. by NH₄OH. Sr(H₂PO₄)₂·2H₂O, <i>strontium phosphate, acid strontium phosphate, monostrontium orthophosphate, primary strontium phosphate.</i> White powder; decomp. by water to SrHPO₄. Sr(PO₃)₂, <i>strontium metaphosphate, monostrontium metaphosphate.</i> White powder; insol. in water and acids. Sr₂P₂O₇·H₂O, <i>strontium pyrophosphate.</i> White powder, amorph. or cryst.; partly sol. in water; easily sol. in HCl or HNO₃; insol. in HC₂H₃O₂ or Na₂P₂O₇ + Aq.	decomp. by H₂SO₄; M. P. 1671°; sp. gr. 3.1. CaHPO₄, <i>calcium phosphate, acid calcium phosphate, dicalcium orthophosphate, secondary calcium phosphate, ordinary calcium phosphate.</i> Pptd. from Ca solns. by Na₂HPO₄; small prismatic cryst. or fine, white, amorph. powder; nearly insol. in water; gradually decomp. by cold, more quickly by hot water; sol. in some Na and NH₄ salt solns.; easily sol. in HCl, HNO₃, H₂SO₄; less sol. in HC₂H₃O₂; insol. in alcohol; forms Ca₃P₂O₇ when heated strongly. Ca(H₂PO₄)₂·H₂O, <i>calcium phosphate, acid calcium phosphate, monocalcium orthophosphate, primary calcium phosphate.</i> Colorless or white, rhombic cryst.; generally very deliq., tho not hygroscopic when pure; strong, acid reaction; somewhat sol. in water, generally with decomp.; sol. in dil. acids. Ca(PO₃)₂, <i>calcium metaphosphate, monocalcium metaphosphate.</i> White powder; insol. in water and dil. acids; decomp. by H₂SO₄. Ca₂P₂O₇·4H₂O, <i>calcium pyrophosphate.</i> Amorph., white powder when pptd.; insol. in water, but sol. in acids, from whose solns. small cryst. separate; sl. sol. in	Unknown. Mg(H₂PO₄)₂·2H₂O, <i>magnesium phosphate, acid magnesium phosphate, monomagnesium orthophosphate, primary magnesium phosphate.</i> Grayish white, cryst. powder; sol. in water without decomp.; decomp. by alcohol. Mg(PO₃)₂, <i>magnesium metaphosphate, monomagnesium metaphosphate.</i> White powder; insol. in water and dil. acids; sol. in concd. H₂SO₄. Mg₂P₂O₇·3H₂O, <i>magnesium pyrophosphate.</i> White, cryst. or amorph. powder; insol. in water; easily sol. in HCl or HNO₃; sol. in H₂SO₄ or Na₂P₂O₇ + Aq;

Barium	Strontium	Calcium	Magnesium	
HNO_3 ; loses its cryst. water at 100° .		$\text{HC}_2\text{H}_3\text{O}_2$; insol. in $\text{Na}_2\text{P}_2\text{O}_7 + \text{Aq}$ or $\text{NH}_4\text{Cl} + \text{Aq}$.	loses its cryst. water at 100° .	Phosphate. Cont.
BaHPO_3 , <i>barium phosphite, normal barium phosphite</i> . Soft, white, cryst. powder; very sl. sol. in cold water, decomp. by hot; sol. in H_3PO_3 , HCl and $\text{NH}_4\text{Cl} + \text{Aq}$; decomp. when heated dry.	$\text{SrHPO}_3 \cdot \text{H}_2\text{O}$, <i>strontium phosphite, normal strontium phosphite</i> . White, cryst. powder; sol. with difficulty in water; the aq. soln. decomp. when heated; the dry salt decomp. at high temp.	$2\text{CaHPO}_3 \cdot 3\text{H}_2\text{O}$, <i>calcium phosphite, normal calcium phosphite</i> . Small, white cryst.; sol. in water; the aq. soln. decomp. when heated; insol. in alcohol; part of cryst. water is lost at 100° , the rest at 200° to 300° ; at higher temp. the salt decomp.	$\text{MgHPO}_3 \cdot 3\text{H}_2\text{O}$, <i>magnesium phosphite, normal magnesium phosphite</i> . White, cryst. powder; sparingly sol. in water; decomp. at high heat.	Phosphite
BaSiO_3 , <i>barium silicate, barium metasilicate</i> . White powder; insol. in cold water; somewhat sol. in boiling water; sol. in HCl ; M. P. 1604° ; sp. gr. 4.4.	SrSiO_3 , <i>strontium silicate, strontium metasilicate</i> . White, amorph. powder; sl. sol. in water; sol. in acids; M. P. 1580° ; sp. gr. 3.6.	CaSiO_3 , <i>calcium silicate, calcium metasilicate, wollastonite, clinoenstatite, enstatite, pseudowollastonite</i> . White, amorph. powder or masses of varying composition; insol. or slowly sol. in water; sol. in HCl ; sp. gr. 2.9.	$\text{MgSiO}_3(?)$, <i>magnesium silicate, magnesium metasilicate, williamsite, sepiolite, soapstone, steatite, talc, talcum, French chalk, Fuller's earth, meerschaum, potstone, verde antique</i> . Fine, white powder of varying composition; insol. in water; sol. in acids.	Silicate
BaSiF_6 , <i>barium silicofluoride, barium fluosilicate</i> . Microscopic, characteristic cryst., round prisms with both ends pointed; insol. in water; sl. sol. in HCl or HNO_3 ; insol. in alcohol; sp. gr. 4.3.	$\text{SrSiF}_6 \cdot 2\text{H}_2\text{O}$, <i>strontium silicofluoride, strontium fluosilicate</i> . White powder or monoclinic cryst.; sol. in alkalies, alcohol and dil. H_2SiF_6 ; decomp. by water or acids; sp. gr. 2.9.	$\text{CaSiF}_6 \cdot 2\text{H}_2\text{O}$, <i>calcium silicofluoride, calcium fluosilicate</i> . White powder or cryst. masses; slowly sol. in and partly decomp. by water; sol. in HCl , HF , H_2SiF_6 and alcohol.	$\text{MgSiF}_6 \cdot 6\text{H}_2\text{O}$, <i>magnesium silicofluoride, magnesium fluosilicate</i> . Efflor.; nearly sol. in water.	Silicofluoride
BaSO_4 , <i>barium sulfate, normal barium sulfate, baryte, barytes, heavy spar, permanent white, terra ponderosa, mineral white, new white, snow white, constant white, baryta white, barytes white, blanc fixe, heavy white, basofor, crested barytes, cockscomb barytes, fixed white</i> . Colorless, rhombic cryst., when native; when pptd. it is a fine, white, amorph. powder; insol. in water; sparingly sol. in HCl . HNO_3 and $\text{HC}_2\text{H}_3\text{O}_2$; sol. in hot, concd. H_2SO_4 ; insol. in $\text{NH}_4\text{Cl} + \text{Aq}$; melts when strongly heated to 1580° ; decomp. at white heat; sp. gr. 3.9.	SrSO_4 , <i>strontium sulfate, normal strontium sulfate, celestite</i> . Colorless, rhombic cryst., when native; when pptd. it is a fine, white, amorph. powder; insol. in water; sparingly sol. in HCl . HNO_3 and $\text{HC}_2\text{H}_3\text{O}_2$; sol. in hot, concd. H_2SO_4 ; insol. in $\text{NH}_4\text{Cl} + \text{Aq}$; melts when strongly heated to 1580° ; decomp. at white heat; sp. gr. 3.9.	$\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$, <i>calcium sulfate, normal calcium sulfate, gypsum, alabaster, gypsite, satinspar, selenite, terra alba, terra blanche, mineral white, light spar, satin spar, satinite, sand plaster</i> . Transparent to white, six-sided, monoclinic prisms or white powder; very sl. sol. in water; loses its cryst. water at 80° ; the anhydrous salt then sets up in a	$\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$, <i>magnesium sulfate, normal magnesium sulfate, Epsom salts, bitter salt, Lemery's salt, hair salt, epsomite, kieserite, salts, salts of England</i> . Small, odorless, colorless prisms or needles; bitter, saline taste; sol. in water; insol. in alcohol; M. P. 70° ; loses $6\text{H}_2\text{O}$ at 150° to 160° , the last molecule at c. 280° ; sp. gr. 1.7. MgSO_4 , <i>anhydrous</i>	Sulfate

Ba, Sr, Ca, Mg GROUP

Sulfate
Cont.

Barium	Strontium	Calcium	Magnesium
is a heavy, white, amorph. powder; insol. in water, HCl, HNO ₃ , HC ₂ H ₃ O ₂ and dil. H ₂ SO ₄ ; sol. in hot concd. H ₂ SO ₄ or in fuming H ₂ SO ₄ ; sol. in NH ₄ NO ₃ +Aq; very sl. sol. in NH ₄ Cl+Aq; M. P. 1580° (?); sp. gr. 4.4.		hard mass; sp. gr. 2.3. CaSO ₄ , <i>anhydrous calcium sulfate, anhydrite, plaster of Paris, calcined gypsum</i> . Colorless, rhombic cryst. when native; fine, white, amorph. powder; sl. sol. in water, 0.17 g. in 100 g. of soln. at 0°, 0.20 g. at 20°, 0.16 g. at 100°; somewhat sol. in HCl or HNO ₃ ; sol. in hot, concd. H ₂ SO ₄ ; insol. in alcohol; melts at red heat; decomp. at white heat; M. P. 1450°; sp. gr. 2.9. 2CaSO ₄ ·H ₂ O, <i>hemihydrated calcium sulfate, plaster of Paris, burnt plaster</i> . White amorph. powder; similar to CaSO ₄ .	<i>magnesium sulfate</i> . White, amorph. masses; bitter, astringent taste; very slowly sol. in water, 27 g. in 100 g. of water at 0°, 36 g. at 20°, 73 g. at 100°; sol. in H ₂ SO ₄ , HCl and HNO ₃ ; M. P. 1185°; sp. gr. 2.6.

Ba(HSO₄)₂·2H₂O, *acid barium sulfate, barium bisulfate*. Fine needles; decomp. by water and alcohol; melts without decomp. at c. 100°.

Sr(HSO₄)₂·H₂O, *acid strontium sulfate, strontium bisulfate*. Lustrous, tabular cryst.; decomp. by water or when heated.

Ca(HSO₄)₂, *acid calcium sulfate, calcium bisulfate*. Colorless prisms or white, finely cryst. powder; somewhat unstable in air; decomp. by water.

Mg(HSO₄)₂, *acid magnesium sulfate, magnesium bisulfate*. White prisms or six-sided tablets; sol. in water with decomp.; sol. in H₂SO₄.

Sulfide

BaS, *barium sulfide, barium monosulfide, Bolognian phosphorus, Bononian phosphorus*. White, yellowish or reddish amorph. powder; sol. in water with decomp.; oxidizes in moist air; exposed to sunlight, and then placed in the dark, it gives off light; sp. gr. 4.2.
BaS·6H₂O, *hydrated barium monosulfide*. Colorless, transparent, six-sided tablets; sl. sol. in cold, sol. in hot water with decomp.; insol. in, but decomp. by boiling alcohol; loses cryst. water between 100° and

SrS, *strontium sulfide, strontium monosulfide*. White powder that turns yellowish slowly on exposure to air; sol. in water with decomp.; sol. in acids; phosphoresces like BaS; sp. gr. 3.7.

Two *polysulfides* are said to exist,—SrS₄ and SrS₅,—both solids.

CaS, *calcium sulfide, calcium monosulfide, sulfuretted lime, calcic liver of lime, Jaune brilliant, oldhamite*. Grayish or yellowish white, amorph. powder, with H₂S odor; phosphorescent; sparingly sol. in water with partial decomp., H₂S being evolved; sol. in acids; does not melt when heated; sp. gr. 2.8.

Two *polysulfides* are said to exist,—CaS₄ and CaS₅,—both known only in soln.

MgS, *magnesium sulfide, magnesium monosulfide*. Yellowish gray, porous, amorph. masses or red-brown, microscopic cryst.; decomp. by water, giving H₂S; sol. in acids with decomp.; sp. gr. 2.8.
Three *polysulfides*,—MgS₃, MgS₄, MgS₅,—are said to exist in soln.

Barium	Strontium	Calcium	Magnesium	Sulfide <i>Cont.</i>
350°, with partial decomp. Several <i>polysulfides</i> are said to exist,—BaS ₂ , BaS ₄ , BaS ₅ and Ba ₂ S ₇ .				
BaSO ₃ , <i>barium sulfite, normal barium sulfite</i> . White powder or fine, colorless, hexagonal, prismatic needles; insol. in water; sol. in warm H ₂ SO ₄ .	SrSO ₃ , <i>strontium sulfite, normal strontium sulfite</i> . Fine, white, cryst. powder that oxidizes slowly to SrSO ₄ on standing; insol. in water; sol. in H ₂ SO ₄ ; decomp. by heat, the residue phosphorescing yellow or yellowish green.	CaSO ₃ ·2H ₂ O, <i>calcium sulfite, normal calcium sulfite</i> . Small, lustrous cryst. or white powder that oxidizes slowly to CaSO ₄ on standing; insol. in water; sol. in H ₂ SO ₄ ; loses its cryst. water at 100°; decomp. by heat. Ca(HSO ₃) ₂ , <i>acid calcium sulfite, calcium bisulfite</i> . Known only in soln.	MgSO ₃ ·6H ₂ O, <i>magnesium sulfite, normal magnesium sulfite</i> . Colorless, hexagonal cryst. or white cryst. powder, which gradually changes to the sulfate on standing; sol. in water, more in hot than in cold; easily sol. in H ₂ SO ₄ ; pptd. from aq. soln. by alcohol; loses all its cryst. water at 200° and decomp. at higher temp.	Sulfite
BaC ₄ H ₄ O ₆ , <i>barium tartrate</i> . White, granular powder; insol. in water; sol. in BaCl ₂ +Aq, NaKC ₄ H ₄ O ₆ +Aq, HCl and HNO ₃ .	SrC ₄ H ₄ O ₆ ·4H ₂ O, <i>strontium tartrate</i> . Colorless, monoclinic, prismatic cryst.; sl. sol. in water.	CaC ₄ H ₄ O ₆ ·4H ₂ O, <i>calcium tartrate</i> . White, cryst. powder; or small, trimetric prisms; very sl. sol. in water; sol. in NaOH + Aq, HCl, HNO ₃ and HC ₂ H ₃ O ₂ . Ca(HC ₄ H ₄ O ₆) ₂ , <i>acid calcium tartrate, calcium bitartrate</i> . Colorless, rhombic, trimetric, cryst. or white powder; sol. in water.	MgC ₄ H ₄ O ₆ ·4H ₂ O, <i>magnesium tartrate</i> . White powder; sl. sol. in water; sol. in acids.	Tartrate
Ba(SCN) ₂ ·2H ₂ O, <i>barium thiocyanate, barium sulfocyanide, barium sulfocyanate</i> . Yellowish white, cryst. powder or long lustrous, white deliq. needles; very sol. in water or alcohol; decomp. when heated in air.	Sr(SCN) ₂ ·3H ₂ O, <i>strontium thiocyanate, strontium sulfocyanide, strontium sulfocyanate</i> . White powder; easily sol. in water or alcohol; loses its cryst. water at 100°; decomp. at 160° to 170°.	Ca(SCN) ₂ ·3H ₂ O, <i>calcium thiocyanate, calcium sulfocyanide, calcium sulfocyanate</i> . White, deliq., cryst. powder; sol. in water or alcohol.	Mg(SCN) ₂ ·4H ₂ O, <i>magnesium thiocyanate, magnesium sulfocyanide, magnesium sulfocyanate</i> . White or clear, colorless deliq. cryst.; sol. in water or alcohol.	Thiocyanate
BaS ₂ O ₃ ·H ₂ O, <i>barium thiosulfate, barium hyposulfite</i> . White, cryst. powder, leaflets or needles; sol. with difficulty in water; insol. in alkalies or alcohol; decomp. by acids; loses its	SrS ₂ O ₃ ·5H ₂ O, <i>strontium thiosulfate, strontium hyposulfite</i> . Small needles or large, monoclinic cryst.; efflor. in air; sol. in water; loses its cryst. water at 100° to 180°, and	CaS ₂ O ₃ ·6H ₂ O, <i>calcium thiosulfate, calcium hyposulfite</i> . White or clear, large, six-sided, triclinic prisms; sol. in water; insol. in alcohol; efflor. at 40°; decomp. on stand-	MgS ₂ O ₃ ·6H ₂ O, <i>magnesium thiosulfate, magnesium hyposulfite</i> . Small, white or colorless, rhombic prisms; very easily sol. in water; insol. in alkalies or alcohol; loses 3H ₂ O at 170°.	Thio-sulfate

Ba, Sr, Ca, Mg GROUP

	Barium	Strontium	Calcium	Magnesium
Thio-sulfate Cont.	cryst. water at 170°; decomp. at red heat; sp. gr. 3.4.	decomp. at red heat.	ing, forming CaSO_4 and S.	and gives off SO_2 and S at red heat, leaving MgSO_4 and MgO .
Tungstate	BaWO_4 , barium tungstate, barium orthotungstate, barium wolframate, wolframite, constant white, barium white. White powder or lustrous, colorless, octahedral cryst.; insol. in water; when pptd. it is very sol. in $\text{NH}_4\text{NO}_3 + \text{Aq}$; melts with difficulty; decomp. by boiling mineral acids, with separation of canary-yellow WO_3 .	SrWO_4 , strontium tungstate, strontium orthotungstate, strontium wolframate. Fine powder; insol. in water; decomp. by boiling mineral acids, with separation of canary-yellow WO_3 ; sp. gr. 6.2.	CaWO_4 , calcium tungstate, calcium orthotungstate, calcium wolframate, scheelite. Fine powder or quadratic octahedra; insol. in water or dil. acids; decomp. by boiling mineral acids, with separation of canary-yellow WO_3 .	MgWO_4 , magnesium tungstate, magnesium orthotungstate, magnesium wolframate. Glassy prisms or white octahedra; insol. in water; decomp. by boiling mineral acids, with separation of canary-yellow WO_3 .

GROUP III

Aluminium	Al
Chromium	Cr

GROUP IV

Iron	Fe
Cobalt	Co
Nickel	Ni
Manganese	Mn
Zinc	Zn

The members of Groups III and IV are generally gray, heavy, lustrous metals which do not decompose water at ordinary temperatures, but are generally soluble in the mineral acids. The valence is not constant, but varies in all cases, except Zn; it is generally 2, 3, 4, or 6. No general formulas can be given for the oxides, because nearly all the members form several oxides, Al and Zn being the only members that form only one oxide.

The metals of these two groups show considerable tendency to form *ous* and *ic* compounds. About half of the iron compounds are ferrous compounds; the other half are ferric; of the compounds of Co, Ni, and Mn, nearly all exist in the *ous* state and only a few in the *ic* state; practically all the compounds of Al, Cr, and Zn are in the *ic* state, while *ous* compounds of these three metals are rare.

The halogen compounds, the nitrates, chlorates, acetates, and sulfates are soluble in water; all the other salts, together with the oxides and hydroxides, are generally insoluble in water, but soluble in acids, except the ferrocyanides and the ferricyanides, which are insoluble in acids, but soluble in alkalis.

These metals show a strong tendency to form colored salts. Cr compounds are generally green or violet. Manganous salts are usually colored pink when crystallized, but blue when anhydrous. Cobaltous salts are usually red or pink when crystallized, but blue when anhydrous. Nickelous salts are usually green when crystallized, but yellow when anhydrous. Ferrous salts are usually greenish when crystallized, but white, yellow, or bluish when anhydrous. Ferric salts are usually yellow or brown. Al and Zn salts are generally white. Members of Group IV as well as Cr may be recognized by the characteristic colors which their compounds give when fused with a borax bead. None of these metals give satisfactory flame colorations.

Al, Cr, Fe, Co, Ni, Mn, Zn GROUP

Metal

Aluminium	Chromium	Iron
Al, aluminium. Tin-white metal; gray when in powder; odorless, tasteless, tenacious, sonorous, malleable, ductile; capable of taking a brilliant polish; not volatile; melts fairly easily and forms octahedral cryst. on cooling; very sl. magnetic; occurs in ingots, sheet, ribbon, wire, powder, and leaf; stable in air, but becomes covered with a thin coating of Al_2O_3 when heated in oxygen; decomp. water at 100°, with evolution of H_2; easily sol. in dil. or concd. HCl, whether hot or cold; also in HBr, HI and HF; dil. H_2SO_4 evolves H_2, leaving $Al_2(SO_4)_3$; concd. H_2SO_4 evolves SO_2, slowly in the cold, easily when hot; unaffected by dil. or concd. HNO_3; very sl. sol. in $HC_2H_3O_2$; very easily sol. in dil. or concd. NaOH or KOH solns., with formation of H_2 and Na or K aluminate; slowly attacked by hydroxides of NH_4, Ba and Ca; less easily attacked than ordinary metals by air, water and foods; unites directly with the halogens; forms alloys with most of the metals; commercial Al contains traces of Fe and Si, and oxidizes more easily than the pure metal. At. No. 13; At. Wt. 26.96; Mol. Wt. unknown; val. 3; sp. gr. 2.702; M. P. 660°; does not vaporize even at very high temp.; B. P. 1800°; one isotope.	Cr, chromium. Shiny, steel-gray powder, consisting of extremely small, lustrous, very hard, brittle, rhombohedral cryst.; occurs also massive; as hard as corundum; less fusible than Pt; not magnetic; oxidizes very slowly in air; burns brightly when heated in oxygen; does not decomp. boiling water; sol. in dil. HCl, giving H_2 and $CrCl_3$; sol. in dil. H_2SO_4, slowly cold, easily in hot, giving H_2 and $Cr_2(SO_4)_3$; only sl. sol. in dil. or concd. HNO_3; nearly insol. in aqua regia; unites directly with chlorine, giving $CrCl_3$; Cr compounds color the borax or salt of phosphorus bead green in both outer and inner flame of the blowpipe. At. No. 24; At. Wt. 52.01; Mol. Wt. unknown; val. 2, 3, 6 and 7; sp. gr. 7.1; M. P. 1615°; B. P. 2200°.	Fe, iron. Gray or silver-white, hard, malleable, ductile metal; cryst. in regular cubes or octahedra; occurs in all forms from powder to large ingots; has a good luster when polished; seldom found chemically pure; technical or ordinary iron usually contains small amounts of C, P, Si and Mn; the physical properties are considerably changed by hammering, bending, rolling, etc.; stable in dry air; in moist air it "rusts" to the oxide, probably $Fe_2O_3 \cdot xH_2O$; somewhat magnetic; finely divided Fe decomp. water at 100°; compact Fe decomp. steam at red heat, leaving Fe_2O_3; sol. in dil. HCl and H_2SO_4, with evolution of H_2 and the formation of ferrous or ferric salts, according to the factor that is in excess; concd. H_2SO_4 does not react with Fe in the cold, when hot it forms SO_2 and $Fe_2(SO_4)_3$; cold, dil. HNO_3 dissolves Fe without the evolution of any gas, but with the formation of NH_4NO_3 and $Fe(NO_3)_2$; an excess of hot HNO_3 dissolves it with formation of $Fe(NO_3)_3$ and NO; not attacked by alkalis; combines directly with the halogens; by some concd. acids Fe is rendered passive, that is, inactive towards reagents, acids included; Fe compounds color the borax or salt of phosphorus bead brownish red in the oxidizing flame while hot, yellow or colorless when cold; the bead becomes bottle-green in the reducing flame. At. No. 26; At. Wt. 55.84; Mol. Wt. unknown; val. 2 and 3; sp. gr. 7.86; cast iron 7 to 7.6, wrought iron 7.25 to 7.78, steel 7.6 to 7.8; M. P. 1535°; cast iron 1050°, wrought iron 1500°, steel 1300°; volatilizes only at extremely high temp.; B. P. 3000°; 2 isotopes.

Cobalt	Nickel	Manganese	Zinc	Metal
Co, cobalt. Steel-gray, shiny, cryst. plates; hard, very ductile, somewhat malleable; nearly white when polished; sl. magnetic; occurs in cubes, granules or powder; stable in air at ordinary temp., but burns at white heat to Co_3O_4; decomp. steam when heated; slowly sol. in dil. HCl, H_2SO_4, more rapidly in HNO_3; hot, concd. H_2SO_4 or HNO_3 evolve SO_2 or NO; sol. in $\text{KOH} + \text{Aq}$ when finely divided; unites directly with the halogens; concd. acids render it passive; Co compounds color the borax or salt of phosphorus bead blue in both oxidizing and reducing flames. At. No. 27; At. Wt. 58.97; Mol. Wt. unknown; val. 2 or 3; sp. gr. 8.9; M. P. 1480°; B. P. 2900°; 1 isotope.	Ni, nickel. Highly lustrous, hard, ductile, malleable, tenacious, sl. grayish white metal; takes a good polish; occurs in ingots, granulated, sheets and wire; sl. magnetic, but less so than Fe or Co; brittle when pure, but malleable when alloyed with a little Mg; does not oxidize at ordinary temp.; heated in air it oxidizes superficially to NiO; sol. in dil. HCl, H_2SO_4 or HNO_3; concd. HNO_3 renders it passive; not attacked by NaOH; combines with the halogens when heated; Ni compounds color the borax or salt of phosphorus bead brownish red in the oxidizing flame while hot, but yellow or colorless when cold; the bead becomes gray in the reducing flame. At. No. 28; At. Wt. 58.69; Mol. Wt. unknown; val. 2 and 3; sp. gr. 8.9; M. P. 1452°; B. P. 2900°; 2 isotopes.	Mn, manganese. Very hard, brittle, steel-gray lumps, with lustrous, metallic fracture; takes a high polish; not magnetic; oxidizes in air or oxygen to MnO; decomp. water readily in the cold, more readily when hot, evolving H_2; sol. in dil. HCl, HNO_3, H_2SO_4 and $\text{HC}_2\text{H}_3\text{O}_2$; rapidly attacked by hot H_2SO_4 or HNO_3; sol. in $\text{NaOH} + \text{Aq}$; unites directly with chlorine and bromine; Mn compounds color the borax or salt of phosphorus bead amethyst red in the oxidizing flame, but colorless in the reducing flame. At. No. 25; At. Wt. 54.93; Mol. Wt. probably the same; val. 2, 3, 4, 6 and 7; sp. gr. 7.2; M. P. 1260°; B. P. 1900°; volatilizes only at extremely high temp.; 1 isotope.	Zn, zinc. Bluish white metal, with cryst. fracture; occurs in ingots, sheets, sticks, mossy, granulated, powder and dust; stable in dry air; in moist air it becomes covered with a thin, white, protective coating of hydrated carbonate; very lustrous when polished; softer than Cu; hardness is increased, sonorousness decreased by rolling; cryst. easily when pure in hexagonal plates or pyramids; commercial Zn is brittle at ordinary temp., but becomes malleable between 100° and 150°; at 210° it becomes brittle again and can be powdered in a mortar; burns with a bluish green flame when heated, forming fluffy ZnO, called "Philosopher's Wool"; pure Zn is unaffected by water, commercial Zn decomp. boiling water, producing H_2; pure Zn is very slowly acted on by acids; a sl. admixture of another metal increases the action; commercial Zn dissolves readily in dil. HCl or H_2SO_4, forming H_2 and ZnCl_2 or ZnSO_4; concd. H_2SO_4 reacts very slowly; HNO_3 gives mostly $\text{Zn}(\text{NO}_3)_2$, tho some NH_4NO_3 is also formed, and N oxides are evolved; easily sol. in $\text{NaOH} + \text{Aq}$ or $\text{KOH} + \text{Aq}$, giving H_2 and Na or K zincate; sol. in NH_4OH, especially if in contact with Fe; unites directly with the halogens when heated; compounds do not discolor borax bead. At. No. 30; At. Wt. 65.38; Mol. Wt. probably the same; val. 2; sp. gr. 7.140; M. P. 419.4°; B. P. 907°; 4 isotopes.	

Al, Cr, Fe, Co, Ni, Mn, Zn GROUP

	Aluminium	Chromium	Iron(ferrous)	Iron(ferric)
Acetate	$\text{Al}(\text{C}_2\text{H}_3\text{O}_2)_3$, <i>aluminium acetate</i>, fluid gelatin, lemeet, mordant salts, oil pulp, printers' acetate, waterproofing salt. Known only in soln. which decomp. when evaporated. $\text{Al}_2\text{O}(\text{C}_2\text{H}_3\text{O}_2)_4$, $4\text{H}_2\text{O}$, <i>basic aluminium acetate</i>. Gummy masses or white, granular, deliq. powder; sol. in water.	$\text{Cr}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot \text{H}_2\text{O}$, <i>chromium acetate</i>, <i>chromous acetate</i>. Red, transparent cryst. that when moist absorb O_2 rapidly from the air, sometimes taking fire. $\text{Cr}(\text{C}_2\text{H}_3\text{O}_2)_3 \cdot \text{H}_2\text{O}$, <i>chromium acetate</i>, <i>chromic acetate</i>. Grayish powder or bluish green, pasty, cryst. mass; sol. in water; insol. in alcohol.	$\text{Fe}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot 4\text{H}_2\text{O}$, <i>iron acetate</i>, <i>ferrous acetate</i>. Small, colorless, silky needles; easily sol. in water; absorbs O_2 from the air readily.	$\text{Fe}_2(\text{C}_2\text{H}_3\text{O}_2)_6$ (?), <i>iron acetate</i>, <i>ferric acetate</i>. Brownish red scales of doubtful compn.; generally found in soln. $\text{Fe}_2(\text{OH})_2$, $(\text{C}_2\text{H}_3\text{O}_2)_4$, <i>basic ferric acetate</i>. Red, amorph. powder; insol. in water.
Arsenate	AlAsO_4, <i>aluminium arsenate</i>, <i>aluminium arseniate</i>. White powder; insol. in water; sol. in acids with difficulty. Unknown.	CrAsO_4, (?) <i>chromium arsenate</i>, <i>chromic arsenate</i>, <i>chromium arseniate</i>. Green, amorph. powder of uncertain compn.; insol. in water and acids. Unknown.	$\text{Fe}_2(\text{AsO}_4)_2 \cdot 6\text{H}_2\text{O}$ (?), <i>iron arsenate</i>, <i>ferrous arsenate</i>, <i>ferrous arseniate</i>. White powder that oxidizes when drying; insol. in water and in solns. of NH_4 salts; sol. in acids. Unknown.	$\text{FeAsO}_4 \cdot 4\text{H}_2\text{O}$, <i>iron arsenate</i>, <i>ferric arsenate</i>, <i>normal ferric arsenate</i>, <i>ferric arseniate</i>. Yellowish white powder; insol. in water; sol. in HCl, HNO_3 and H_2SO_4; insol. in $\text{HC}_2\text{H}_3\text{O}_2$. $\text{Fe}(\text{H}_2\text{AsO}_4)_2$ (?), <i>acid ferric arsenate</i>. White ppt. of doubtful compn.; insol. in water and acids.
Arsenite	Unknown.	CrAsO_3, <i>chromium arsenite</i>, <i>chromic arsenite</i>. Dark green powder; sol. in cold water; decomp. by boiling water.	$\text{Fe}_2(\text{AsO}_3)_2$, <i>iron arsenite</i>, <i>ferrous arsenite</i>. Greenish white powder that turns yellow on standing; insol. in water and in solns. of NH_4 salts; sol. in acids and with greenish yellow color in NH_4OH.	FeAsO_3, <i>iron arsenite</i>, <i>ferric arsenite</i>. The existence of the normal salt is doubtful; the ppt. ordinarily obtained has the formula $4\text{Fe}_2\text{O}_3 \cdot \text{As}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$; yellow powder, darkens when dried; insol. in water and in $\text{HC}_2\text{H}_3\text{O}_2$; sol. in acids.
Borate	$2\text{Al}_2\text{O}_3 \cdot \text{B}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$, <i>aluminium borate</i>. White, granular powder of variable compn.; insol. in water; sol. in acids.	CrB_2O_4 (?), <i>chromium borate</i>, <i>chromous borate</i>. Powder of variable compn.; insol. in water; sol. in acids.	FeB_2O_4 (?), <i>iron borate</i>, <i>ferrous borate</i>. Powder of variable compn.; insol. in water; sol. in acids.	$\text{Fe}(\text{B}_2\text{O}_4)_2 \cdot 3\text{H}_2\text{O}$, <i>iron borate</i>, <i>ferric borate</i>. Powder of variable compn.; insol. in water; sol. in acids.
Bromate	$\text{Al}(\text{BrO}_3)_3$, <i>aluminium bromate</i>. Deliq. masses; sol.	Unknown.	$\text{Fe}(\text{BrO}_3)_2$, <i>iron bromate</i>, <i>ferrous bromate</i>. Cryst.	$5\text{Fe}_2\text{O}_3 \cdot \text{Br}_2\text{O}_3$, $30\text{H}_2\text{O}$, <i>basic ferric bromate</i>. Fine,

Cobalt	Nickel	Manganese	Zinc	
Co(C₂H₃O₂)₂·4H₂O, <i>cobalt acetate, cobaltous acetate</i>. Small, reddish violet, deliq. cryst.; sol. in water; sp. gr. 1.7.	Ni(C₂H₃O₂)₂·4H₂O, <i>nickel acetate, nickelous acetate</i>. Apple-green prisms or dark green, cryst. crusts; sol. in water; insol. in alcohol; sp. gr. 1.7.	Mn(C₂H₃O₂)₂·4H₂O, <i>manganese acetate, manganous acetate</i>. Transparent, pale red, monoclinic cryst.; sol. in water or alcohol; sp. gr. 1.6.	Zn(C₂H₃O₂)₂·3H₂O, <i>zinc acetate</i>. White, monoclinic plates with pearly luster; sol. in water, 40 g. in 100 g. of water at 25°. Zn(C₂H₃O₂)₂, <i>anhydrous zinc acetate</i>. White, molten crusts; sol. in water with turbidity; M. P. 142°; sp. gr. 1.8.	Acetate
Co₂(AsO₄)₂·8H₂O, <i>cobalt arsenate, cobaltous arsenate, normal cobaltous arsenate, cobaltous arsenate, cobalt bloom, erythrite, fly stone</i>. Violet, monoclinic needles or violet powder; deep blue when dry; insol. in water; sol. in HNO₃, HCl, NH₄OH and H₃AsO₄; sp. gr. 2.9.	Ni₂(AsO₄)₂·2H₂O, <i>nickel arsenate, nickelous arsenate, nickelous arsenate</i>. Dark green, hexagonal plates or light green, finely cryst. powder; insol. in water; sol. in acids with difficulty.	Mn₃(AsO₄)₂·H₂O, <i>manganese arsenate, manganous arsenate, normal manganous arsenate, manganous arsenate</i>. Brown needles; insol. in water; sl. sol. in acids.	Zn₂(AsO₄)₂·3H₂O, <i>zinc arsenate, normal zinc arsenate, zinc arsenate, adamine</i>. Gelatinous ppt.; insol. in water; sol. in HNO₃ or H₃AsO₄.	Arsenate
Co(H₂AsO₄)₂, <i>acid cobaltous arsenate</i>. Red, cryst. masses; sol. in water.	Unknown.	MnHASO₄, <i>acid manganous arsenate</i>. Reddish white, deliq. powder; sl. sol. in water; sol. in acids.	ZnHASO₄·H₂O, <i>acid zinc arsenate</i>. White powder, needles or tablets; insol. in water; sol. in acids.	
Co₂(AsO₃)₂, <i>cobalt arsenite, cobaltous arsenite, normal cobaltous arsenite</i>. Rose-red powder that darkens when dried; insol. in water; sol. in acids.	3NiO·2As₂O₃·4H₂O, <i>nickel arsenite, nickelous arsenite</i>. Apple-green powder; insol. in water; sol. in acids, and with a violet color in NH₄OH.	Mn₂H₂(AsO₃)₄·2H₂O, <i>manganese arsenite, manganous arsenite</i>. Pale rose-red powder that darkens in the air; insol. in water; sol. in acids.	Zn₂(AsO₃)₂, <i>zinc arsenite</i>. White, lustrous, cryst. powder; insol. in water; sol. in acids.	Arsenite
Co₂H₂(AsO₃)₄, <i>acid cobaltous arsenite</i>. Rose-red powder; insol. in H₂O; sol. in HNO₃, HCl and NH₄OH.				
2CoB₂O₃·CoO·H₂·3H₂O, <i>cobalt borate, cobaltous borate</i>. Powder of variable compn.; insol. in water; sol. in acids.	NiB₂O₃·2H₂O, <i>nickel borate, nickelous borate</i>. Powder of variable compn.; insol. in water; sol. in acids.	MnB₂O₃, <i>manganese borate, manganous borate</i>. Whitish powder of variable compn.; insol. in water; sol. in acids.	3ZnO·2B₂O₃, <i>zinc borate</i>. White powder of variable compn.; insol. in water; sol. in acids.	Borate
Co(BrO₃)₂·6H₂O, <i>cobalt bromate, cobaltous bromate</i>.	Ni(BrO₃)₂·6H₂O, <i>nickel bromate, nickelous bromate</i>.	Unknown.	Zn(BrO₃)₂·6H₂O, <i>zinc bromate</i>. White, deliq. pow-	Bromate

Al, Cr, Fe, Co, Ni, Mn, Zn GROUP

	Aluminium	Chromium	Iron(ferrous)	Iron(ferric)
Bromate <i>Cont.</i>	in water; cryst. with $9\text{H}_2\text{O}$; M. P. of cryst. 62° .		powder; sol. in water, but the soln. decomp. very easily.	reddish yellow or brown powder; partly sol. in water; sol. in HNO_3 .
Bromide	$\text{AlBr}_3 \cdot 6\text{H}_2\text{O}$, <i>aluminium bromide</i> . Deliq. needles; sol. in water. AlBr_3 , <i>anhydrous aluminium bromide</i> . White, lustrous, very deliq. plates; fumes in air when freshly made; sol. in water, with evolution of much heat; sol. in CS_2 , alkalies and alcohol; melts at 97.5° to a mobile liquid that boils at 265° to 270° ; decomp. when heated dry in air; sp. gr. 3.	CrBr_2 , <i>chromium bromide, chromiumous bromide</i> . White, cryst. powder; not deliq.; astringent taste; turns yellow when heated; dissolves in water to a blue solution; stable in dry air; oxidizes in moist air. $\text{CrBr}_3 \cdot 6\text{H}_2\text{O}$, <i>chromium bromide, chromic bromide</i> . Very deliq., beautiful green needles; sol. in water or alcohol. CrBr_3 , <i>anhydrous chromic bromide</i> . Dark green or red, hexagonal scales with metallic luster; olive green by transmitted light; sublimes when heated; insol. in pure water, but easily sol. in very dil. $\text{CrBr}_2 + \text{Aq}$ to a green solution.	$\text{FeBr}_2 \cdot 6\text{H}_2\text{O}$, <i>iron bromide, ferrous bromide</i> . Blue green, deliq., six-sided cryst.; sol. in water, 50 g. of the anhydrous salt in 100 g. of soln. at 0° , 53 g. at 20° , 64 g. at 100° ; sol. in alcohol. FeBr_3 , <i>anhydrous ferrous bromide</i> . Greenish yellow, cryst. masses; sol. in water; melts with difficulty; decomp. by heat; sp. gr. 4.6.	$\text{FeBr}_3 + \text{Aq}$, <i>iron bromide, ferric bromide</i> . Dark brown liquid or red-brown, tabular cryst. with metallic luster; deliq.; sol. in water or alcohol; M. P. 27° .
Carbide	AlC_3 , <i>aluminium carbide</i> . Yellow or green, transparent cryst.; decomp. by water, forming $\text{Al}(\text{OH})_3$ and CH_4 ; insol. in acetone; insol. in cold fuming HNO_3 ; decomp. by dil. acids; slowly attacked by concd. HCl ; reduces boiling concd. H_2SO_4 to SO_2 ; decomp. by fused KOH at 100° ; stable up to 1400° ; decomp. in electric arc; sublimes without melting; superficially attacked by O_2 at dull red	Cr_3C_2 , <i>chromium carbide, chromium ditritacarbide</i> . Hard, shiny plates with fatty luster; insol. in water, dil. and concd. HNO_3 , concd. HCl , and aqua regia; slowly attacked by dil. HCl ; does not decomp. water at 100° ; insol. in fused KOH ; sol. in fused KNO_3 ; decomp. by Cl_2 at red heat; M. P. 1890° ; sp. gr. 6.68. CrC , <i>chromium carbide, chromium tetracarbide</i> . Hard, reddish-brown needles; sp. gr. 6.75.	FeC_2 , <i>iron carbide, iron dicarbide, ferrous carbide, acetylide</i> . Black pyrophoric powder or yellow solid with silver reflex; slowly attacked by HNO_3 .	Fe_3C , <i>iron carbide, iron tritacarbide, cementite, carbide carbon</i> . Black microscopic granules or small plates or needles; insol. in water and dil. acids; not altered by dry air; oxidizes slowly in moist air, forming Fe_2O_3 , C and $\text{C}_{12}\text{H}_2\text{O}_5$; sol. in hot concd. HCl ; not affected by cold fuming HNO_3 , but attacked by boiling fuming HNO_3 ; M. P. 1837° ; sp. gr. 7.4. The following carbides are said to exist, but they

Cobalt	Nickel	Manganese	Zinc	
Transparent, hyacinth-colored, regular octahedra; sol. in water, but decomp. when the soln. is boiled; sol. in NH_4OH .	Green, octahedral cryst.; decomp. when heated; sol. in water, 27 g. in 100 g. cold water.		der or stable, regular octahedral cryst.; sol. in water, or NH_4OH ; melts at 100° ; loses $6\text{H}_2\text{O}$ at 200° , with partial decomp.	Bromate <i>Cont.</i>
$\text{CoBr}_2 \cdot 6\text{H}_2\text{O}$, cobalt bromide, cobaltous bromide. Red, deliq. cryst.; sol. in water; melts at 100° with decompn. CoBr_2 , anhydrous cobaltous bromide. Green or bluish green powder or lustrous masses; sol. in water, 67 g. in 100 g. of soln. at 60° ; sol. in alcohol; deliq. in air to a red soln.; sp. gr. 4.9.	$\text{NiBr}_2 \cdot 3\text{H}_2\text{O}$, nickel bromide, nickelous bromide. Deliq., greenish scales with metallic luster; sol. in water, NH_4OH and alcohol; loses its cryst. water at c. 200° . NiBr_2 , anhydrous nickelous bromide. Brownish yellow solid that sublimates at strong red heat to yellow lustrous scales; deliq.; slowly sol. in water, 53 g. in 100 g. of soln. at 0° , 57 g. at 20° , 61 g. at 100° ; slowly sol. in alcohol; sp. gr. 4.6.	$\text{MnBr}_2 \cdot 4\text{H}_2\text{O}$, manganese bromide, manganous bromide. Small, rose-red needles or monoclinic, tabular cryst.; deliq.; sol. in water, 56 g. of the anhydrous salt in 100 g. of soln. at 0° , 59 g. at 20° , 69 g. at 100° ; melts in its cryst. water at 64.3° with decomp. MnBr_2 , anhydrous manganous bromide. Light brown, very deliq. powder; sol. in water with decomp.; sp. gr. 4.4.	ZnBr_2 , zinc bromide. White, very deliq., cryst. powder or needles; melts at 394° to a bright yellow liquid that boils at 650° ; sweetish taste; sol. in water, 80 g. in 100 g. of soln. at 0° , 81 g. at 18° , 87 g. at 100° ; sol. in concd. HCl and $\text{HCl}_2\text{H}_2\text{O}_2$, NH_4OH and alcohol; decomp. by HNO_3 ; sp. gr. 4.2.	Bromide
CoC_2 , cobalt carbide, cobaltous carbide. Said to exist. Co_3C , cobalt carbide, cobalt tritacarbide. Said to exist.	NiC_2 , nickel carbide, nickelous carbide. Said to exist. Ni_3C , nickel carbide, nickel tritacarbide. Said to exist; probably dissociates into Ni and C between 900° and 1600° .	MnC_2 , manganese carbide, manganous carbide. Said to exist. Mn_2C , manganese carbide, manganese tritacarbide. Soft, cryst. solid or needle cryst.; high luster; reacts with water giving $\text{Mn}(\text{OH})_2$, CH_4 , and H_2 ; decomp. by dil. acids; burns readily in O_2 ; attacked easily by Cl_2 and F_2 ; dissociates at high temp. into Mn and C; sp. gr. 6.89.	Unknown.	Carbide

Al, Cr, Fe, Co, Ni, Mn, Zn GROUP

	Aluminium	Chromium	Iron(ferrous)	Iron(ferric)
Carbide Cont.	heat; attacked by Cl_2 and Br_2 but not by I_2 ; not attacked by N and P; readily attacked by certain oxidizing agents; reacts with certain metals; sp. gr. 2.36.	Cr_3C_2 , chromium carbide, chromium dipentilacarbide. Silvery cryst.; not attacked by aqua regia; melts at 1665° without decomp.; sp. gr. 6.92.		may be only mixtures: Fe_3C , FeC_3 , Fe_5C_3 , Fe_2C_3 , Fe_3C_2 , FeC , Fe_2C , FeC_4 and Fe_{24}C .
Carbonate	$\text{Al}_2(\text{CO}_3)_3$ (?), aluminium carbonate. The existence of the normal salt is doubtful; alkaline carbonates produce in Al solns. a white, amorph. ppt. of variable compn., generally a basic carbonate that is insol. in water, sol. in acids and gives off CO_2 on sl. heat.	CrCO_3 , chromium carbonate, chromous carbonate. Amorph. grayish white mass or powder; insol. in water; sl. sol. in carbonic acid water. $\text{Cr}_2\text{O}_3 \cdot \text{CO}_2 \cdot 4\text{H}_2\text{O}$, (?) basic chromic carbonate. Amorph. powder of variable compn.; insol. in water; sol. in acids.	FeCO_3 , iron carbonate, ferrous carbonate, normal ferrous carbonate, siderite, spathic iron ore. Grayish white, cryst. powder or solid composed of microscopic rhombohedra; fairly stable in air; heating turns it darker; insol. in water; sol. in HCl , HNO_3 , H_2SO_4 and even in H_2CO_3 . $\text{FeCO}_3 \cdot \text{H}_2\text{O}$, green ferrous carbonate. Generally mixed with Fe oxides; white, amorph., earthy powder when native; ppts. as greenish white, tasteless powder that turns red on exposure to air; insol. in water; sol. in acids; sp. gr. 3.8.	$\text{Fe}_2(\text{CO}_3)_3$ (?), iron carbonate, ferric carbonate. Amorph. powder of variable compn.
	Unknown.	Unknown.	$\text{Fe}(\text{HCO}_3)_2$ (?), acid ferrous carbonate. Known only in solns. of FeCO_3 in H_2CO_3 + Aq.	Unknown.
Chlorate	$\text{Al}(\text{ClO}_3)_3$, aluminium chlorate, mallebrein. White, deliq. masses, easily sol. in water; sol. in alcohol.	$\text{Cr}(\text{ClO}_3)_3$, chromium chlorate, chromic chlorate. Easily sol. in water to a soln. which is violet at ordinary temp., green at 65° , but decomp. when heated.	$\text{Fe}(\text{ClO}_3)_3$, iron chlorate, ferrous chlorate. Known only in aq. soln., which is colorless at first, but turns yellow easily on standing, with formation of ferric chlorate and pptn. of basic ferric chlorate.	$\text{Fe}(\text{ClO}_3)_3$, iron chlorate, ferric chlorate. Sol. in water to reddish yellow soln.; basic ferric chlorate is insol. in water.

Cobalt	Nickel	Manganese	Zinc	Carbide Cont.
CoCO₃, <i>cobalt carbonate, cobaltous carbonate, normal cobaltous carbonate, spherocobaltite</i>. Light rose-colored, cryst. powder; microscopic rhombohedra; insol. in water; sol. in acids; alkaline carbonates ppt. from Co solns. a rose-red, dark blue or violet-gray, amorph. basic Co carbonate of varying compn.; insol. in water; sol. in acids and NH₄ salt solns.	NiCO₃, <i>nickel carbonate, nickelous carbonate</i>. Bluish green, transparent, microscopic rhombohedra; insol. in water and cold, coned. HCl or HNO₃; alkaline carbonates ppt. from Ni solns. a bright green, amorph. Ni carbonate, whose compn. varies with the temp. and strength of the solns.; heated above 100° in air it loses water and CO₂ and is partly reduced to Ni₃O₄; insol. in water; sol. in acids. 3NiO.CO₂.H₂O, <i>basic nickel carbonate, zaraitite</i>. Easily sol. in dil. HCl.	MnCO₃, <i>manganese carbonate, manganous carbonate, rhodochrosite, manganese red, manganese spar, manganese white</i>. Fine, amorph., light brown or faintly rose-colored powder; insol. in water; sol. in acids, even H₂CO₃; heated in air it yields Mn₂O₄; sp. gr. 3.1.	ZnCO₃, <i>zinc carbonate, smithsonite, calamine, zinc spar, spathic zinc ore</i>. White or transparent, hexagonal, rhombohedral cryst., or white amorph. powder; insol. in water; sol. in solns. of KOH and NH₄ salts; sol. in acids, even H₂CO₃; alkaline carbonates ppt. an impalpable, white, amorph. basic Zn carbonate, which varies like the Ni carbonate; insol. in water; sol. in acids; decomp. at 300°; sp. gr. 4.4. xZnO.yCO₂.zH₂O, <i>basic zinc carbonate, zinc bloom, hydrozincite</i>. White; sol. in dil. HCl.	Carbonate
Co(HCO₃)₂, (?) <i>acid cobaltous carbonate</i>. Known only in soln. of CoCO₃ in H₂CO₃+Aq.	Unknown.	Unknown.	Unknown.	
Co(ClO₃)₂.6H₂O, <i>cobalt chlorate, cobaltous chlorate</i>. Very deliq., octahedral cryst.; sol. in water, 57 g. in 100 g. of soln. at 0°, 64 g. at 21°, 76 g. at 61°; sol. in alcohol; melts in its cryst. water at 61°; decomp. at higher temp.; sp. gr. 1.9.	Ni(ClO₃)₂.6H₂O, <i>nickel chlorate, nickelous chlorate</i>. Dark green, very deliq., regular, octahedral cryst.; easily sol. in water, 53 g. in 100 g. of soln. at 0°, 57 g. at 18°, 76 g. at 80°; easily sol. in alcohol; melts in its cryst. water at 80°; begins to decomp. at 140°, forms a black mixture of NiO and NiCl₂ and	Mn(ClO₃)₂, (?) <i>manganese chlorate, manganous chlorate</i>. Known only in soln. which is colorless, and decomp. when heated with formation of MnO₂.H₂.	Zn(ClO₃)₂.6H₂O, <i>zinc chlorate</i>. Colorless, very deliq. cryst. or cryst. masses; sharp taste; easily sol. in water, 59 g. in 100 g. of soln. at 0°, 66 g. at 18°, 75 g. at 55°; sol. in alcohol; melts in its cryst. water at 60° and decomp. at higher temp.	Chlorate

Al, Cr, Fe, Co, Ni, Mn, Zn GROUP

Chlorate
Cont.

Chloride

Aluminium	Chromium	Iron(ferrous)	Iron(ferric)
AlCl₃·6H₂O, <i>aluminium chloride, chloralum, muriate of alumina</i>. Transparent, hexagonal plates or masses, colorless when pure, but often yellowish or yellowish green, because of presence of Fe chlorides; fumes in moist air; sol. in water with evolution of much heat, 41 g. of the anhydrous chloride in 100 g. of soln. at 15°; the aq. soln. losing HCl when heated and leaving Al₂O₃; sol. in alcohol; fusible in large masses, but volatilizes without fusion if heated in small quantities; M. P. 194°; sp. gr. 2.4.	CrCl₃, <i>chromium chloride, chromous chloride, butter of chrome</i>. White, lustrous, hygroscopic needles; sol. in water, with evolution of heat to a blue soln. that absorbs O₂ and turns green; sp. gr. 2.7 CrCl₃·10H₂O, <i>chromium chloride, chromic chloride</i>. Very deliq., triclinic needles; easily sol. in water or alcohol; melts in its cryst. water at 6° to 7°. CrCl₃·6H₂O, <i>chromic chloride</i>. Green cryst.; very sol. in water. CrCl₃, <i>anhydrous chromic chloride</i>. Occurs in two forms, (a) <i>peach-blossom-colored</i>, lustrous plates; insol. in pure water; sol. in water, containing traces of CrCl₃; unaffected by acids, even hot, concd. H₂SO₄ or aqua regia; sublimes at red heat; (b) <i>violet</i>, soft, scale-like, lustrous cryst.; sol. in water to a green soln.; sublimes above 250° to the peach-blossom variety; sp. gr. 2.7.	FeCl₂·4H₂O, <i>iron chloride, ferrous chloride, iron dichloride</i>. Blue green, monoclinic, deliq., transparent cryst.; easily sol. in water, 39 g. of the anhydrous salt in 100 g. of soln. at 10°, 40 g. at 15°, 51 g. at 100°; easily sol. in alcohol; when heated melts in its cryst. water; sp. gr. 1.9. FeCl₂, <i>anhydrous ferrous chloride, laurencite</i>. White, greenish white or yellowish green, lustrous, six-sided, deliq. tablets; oxidizes easily in air; easily sol. in water, with evolution of heat; sol. in alcohol; melts at red heat and sublimes at higher temp.; sp. gr. 2.7.	FeCl₃·6H₂O, <i>iron chloride, ferric chloride, iron trichloride, iron perchloride</i>. Very deliq., orange-yellow cryst. masses, with astringent, chalybeate taste and acid reaction; sol. in water or alcohol; M. P. 31°; congeals at 42°. FeCl₃, <i>anhydrous ferric chloride, molysite</i>. Lustrous, very deliq., hexagonal cryst.; dark red by transmission, greenish by reflected light; ordinarily a brownish black, cryst. mass; sublimes at c. 100°; sol. in water, 74 g. in 100 g. of water at 0°, 92 g. at 20°, 539 g. at 100°, with evolution of great heat to a liquid which is very dark brown when concd., but yellow when dil.; M. P. 282°; sp. gr. 2.8.
Al₂O₃·CrO₃·7H₂O, <i>aluminium chromate, basic aluminium chromate</i>. Flocculent, yellow powder; apparently insol. in water, perhaps decomp. by water; insol. in NH₄Cl+Aq; sol. in NH₄OH or acids, even in HC₂H₃O₂.	Cr₂O₃·CrO₃, <i>chromium chromate</i>. Existence is doubtful; probably identical with CrO₃, chromium dioxide, q.v.	Unknown.	Fe₂(CrO₄)₃, <i>iron chromate, ferric chromate</i>. Steel-blue granules; sol. in water. Fe₂(CrO₄)₃, <i>2Fe₂O₃, basic ferric chromate, siderine yellow</i>. Brown, amorph. powder; insol. in water, but decomp. thereby; sol. in acids.

Chromate

Al, Cr, Fe, Co, Ni, Mn, Zn GROUP

Cobalt	Nickel	Manganese	Zinc	Chlorate Cont.
	gives finally at red heat yellowish gray Ni oxychloride; sp. gr. 2.			
CoCl₂·6H₂O , <i>cobalt chloride, cobaltous chloride</i> . Ruby-red, monoclinic cryst. or short prisms; not deliq.; easily sol. in water; loses its cryst. water easily when heated, giving blue anhydrous Co chloride; M. P. 86°; sp. gr. 1.9.	NiCl₂·6H₂O , <i>nickel chloride, nickelous chloride</i> . Green, monoclinic, four-sided prismatic cryst.; deliq. in moist, efflor. in dry air; sol. in water, with evolution of heat; easily sol. in alcohol.	MnCl₂·4H₂O , <i>manganese chloride, manganous chloride, pink crystals</i> . Deliq., rose-red, monoclinic cryst. or cryst. masses; sol. in water, 63 g. of the anhydrous salt in 100 g. of water at 0°, 74 g. at 20°, 115 g. at 100°; sol. in alcohol; melts in its cryst. water at 58°; sp. gr. 2; B. P. 106°.	ZnCl₂ , <i>zinc chloride, butter of zinc, zinc butter</i> . Very deliq., white powder or grayish white fused lumps; sol. in water, 208 g. in 100 g. of water at 0°, 368 g. at 20°, 615 g. at 100°; sol. in alcohol; caustic, nauseating taste; melts at 365°; boils at c. 730°, and sublimes to white needles; sp. gr. 2.9.	Chloride
CoCl₂ , <i>anhydrous cobaltous chloride</i> . Blue, deliq., cryst. scales; easily sol. in water, forming a reddish liquid, 29 g. in 100 g. of soln. at 0°, 33 g. at 20°, 51 g. at 100°; sol. in abs. alcohol; sublimes without melting when heated.	NiCl₂ , <i>anhydrous nickelous chloride</i> . Golden yellow scales that sublime readily without melting; slowly sol. in water, 35 g. in 100 g. of soln. at 0°, 39 g. at 20°, 47 g. at 100°; more quickly sol. after deliq.; sol. in NH ₄ OH; sp. gr. 3.5.	MnCl₂ , <i>anhydrous manganous chloride, scacchite</i> . Deliq., rose-red, scaly, cryst. masses; sol. in water; melts at red heat, sometimes with decomp; M. P. 650°; sp. gr. 2.9.		
		MnCl₄ , <i>manganese tetrachloride</i> . Has not been isolated; sol. in water or alcohol.		
CoCrO₄·CoO , 2H ₂ O, (?) <i>cobalt chromate, basic cobaltous chromate</i> . Brown powder of variable compn.; insol. in water; sol. in acids.	NiCrO₄·2NiO , 3H ₂ O, (?) <i>nickel chromate, basic nickelous chromate</i> . Red-brown powder of variable compn.; insol. in water; sol. in acids or NH ₄ OH.	MnCrO₄·MnO , 2H ₂ O, (?) <i>manganese chromate, basic manganous chromate</i> . Black or red-brown powder of variable compn.; insol. in water; sol. in acids.	ZnCrO₄·ZnO , 2H ₂ O, <i>zinc chromate, basic zinc chromate, zinc yellow, buttercup yellow, zinc chrome, zinc chrome yellow, citron yellow</i> . Yellow powder; insol. in water; sol. in hot H ₂ CrO ₄ +Aq; slowly sol. in NH ₄ OH.	Chromate

Al, Cr, Fe, Co, Ni, Mn, Zn GROUP

	Aluminium	Chromium	Iron(ferrous)	Iron(ferric)
Chromate <i>Cont.</i>				$\text{Fe}_2(\text{Cr}_2\text{O}_7)_3$, iron bichromate, ferric bichromate, ferric dichromate. Sol. in water or alcohol.
Cyanide	Unknown.	$\text{Cr}(\text{CN})_3$, chromium cyanide, chromic cyanide. Blue-green powder; insol. in water; sol. in acids and in excess of $\text{CrCl}_3 + \text{Aq}$; slowly sol. in $\text{KCN} + \text{Aq}$.	$\text{Fe}(\text{CN})_2$, (?) iron cyanide, ferrous cyanide. Yellowish brown powder of variable compn. and doubtful existence; insol. in water; sol. in $\text{KCN} + \text{Aq}$.	Unknown. KCN ppts. $\text{Fe}_2\text{O}_3\cdot\text{H}_2\text{O}$ from ferric solns.
Ferrocyanide	$\text{Al}_4[\text{Fe}(\text{CN})_6]_3 \cdot 17\text{H}_2\text{O}$, aluminium ferrocyanide. Light brown powder; sl. sol. in water; sl. sol. in HCl , with partial decomp.	$\text{Cr}_2\text{Fe}(\text{CN})_6$, chromium ferrocyanide, chromous ferrocyanide. Yellow, amorph. powder. $\text{Cr}_4[\text{Fe}(\text{CN})_6]_3 \cdot 20\text{H}_2\text{O}$, (?) chromium ferrocyanide, chromic ferrocyanide. Amorph. powder.	$\text{Fe}_2\text{Fe}(\text{CN})_6$, iron ferrocyanide, ferrous ferrocyanide. Amorph. powder; white when pure, but turns blue rapidly on exposure to air; insol. in water or acids.	$\text{Fe}_4[\text{Fe}(\text{CN})_6]_3$, iron ferrocyanide, ferric ferrocyanide, Prussian blue, Paris blue, Berlin blue, Chinese blue, mineral blue, soluble blue, laundry blue, bronze blue, paste blue, Hamburg blue, new blue, Erlangen blue, oil blue, steel blue, Antwerp blue. Very dark characteristic blue powder or lumps; insol. in water, alcohol, NH_4OH and dil. mineral acids; sol. in concd. HCl or H_2SO_4 without decomp.; sol. in $\text{H}_2\text{C}_2\text{O}_4 + \text{Aq}$; sol. in $\text{NaOH} + \text{Aq}$ and in $\text{KOH} + \text{Aq}$, with decomp. and pptn. of $\text{Fe}_2\text{O}_3\cdot\text{H}_2\text{O}$.
Ferricyanide	Unknown.	Ppt. obtained from $\text{K}_2\text{Fe}(\text{CN})_6 + \text{Aq}$ and a Cr soln. is probably Cr ferricyanide, but its compn. is doubtful.	$\text{Fe}_3\text{Fe}_2(\text{CN})_{12}$, iron ferricyanide, ferrous ferricyanide, Turnbull's blue. Very dark blue, amorph. powder; insol. in water, alcohol and dil. mineral acids; sol. in $\text{NaOH} + \text{Aq}$ and in	$\text{Fe}_2\text{Fe}_2(\text{CN})_{12}$, iron ferricyanide, ferric ferricyanide. Sol. in water to a red-brown soln.

Cobalt	Nickel	Manganese	Zinc	Chromate Cont.
Co(CN)₂·2H₂O, <i>cobalt cyanide, cobaltous cyanide</i>. Reddish gray or flesh-colored, amorph. powder; insol. in water; sol. in KCN+Aq, forming sol. K cobalto-cyanide, K₂Co(CN)₆; sol. in NH₄OH or (NH₄)₂CO₃+Aq; insol. in dil. acids; loses its cryst. water at 280°.	Ni(CN)₂·xH₂O, <i>nickel cyanide, nickelous cyanide</i>. Apple-green, amorph. powder; insol. in water; insol. in concd. HCl, H₂SO₄ and HNO₃, but decomp. when heated therewith; sol. in KCN+Aq to a yellow soln., with formation of a double salt, Ni(CN)₂·2KCN; sol. in NH₄OH; loses its cryst. water at c. 200°, the residue turning brown.	Unknown.	Zn(CN)₂, <i>zinc cyanide</i>. White, cryst. powder or lustrous, orthorhombic prisms; insol. in water or alcohol; sol. in alkalies, in dil. acids and in hot solns. of NH₄ salts; sol. in KCN+Aq to a sol. double cyanide, Zn(CN)₂·2KCN; decomp. when heated strongly.	Cyanide
Co₂Fe(CN)₆·7H₂O, (?) <i>cobalt ferrocyanide, cobaltous ferrocyanide</i>. Blue, amorph. powder that changes rapidly to reddish color on exposure to air; insol. in water, NH₄Cl+Aq and HCl; sl. sol. in NH₄OH; sol. in KCN+Aq; sol. in H₂SO₄ with decomp.	Ni₂Fe(CN)₆·11H₂O, <i>nickel ferrocyanide, nickelous ferrocyanide</i>. Greenish white amorph. powder; insol. in water, HCl and solns. of NH₄ salts; sol. in NH₄OH or KCN+Aq.	Mn₂Fe(CN)₆·7H₂O, <i>manganese ferrocyanide, manganous ferrocyanide</i>. Greenish-white powder; insol. in water and solns. of NH₄ salts; sol. in HCl.	Zn₂Fe(CN)₆·3H₂O, <i>zinc ferrocyanide</i>. White powder; insol. in water or acids; sol. in NH₄OH; sl. sol. in solns. of NH₄ salts.	Ferrocyanide
Co₃Fe₂(CN)₁₂, <i>cobalt ferricyanide, cobaltous ferricyanide</i>. Reddish brown powder; insol. in water or acids; sol. in NH₄OH.	Ni₃Fe₂(CN)₁₂, <i>nickel ferricyanide, nickelous ferricyanide</i>. Reddish brown amorph. powder; insol. in water or acids.	Mn₃Fe₂(CN)₁₂, <i>manganese ferricyanide, manganous ferricyanide</i>. Reddish brown, amorph. powder; insol. in water, acids, NH₄OH and solns. of NH₄ salts.	Zn₃Fe₂(CN)₁₂, <i>zinc ferricyanide</i>. Yellowish brown, amorph. powder; insol. in water, NH₄OH and solns. of NH₄ salts; sol. in acids.	Ferricyanide

Al, Cr, Fe, Co, Ni, Mn, Zn GROUP

	Aluminium	Chromium	Iron(ferrous)	Iron(ferric)
Ferri-cyanide Cont.			KOH+Aq with decomp., but without pptn. of $\text{Fe}_2\text{O}_3\cdot\text{H}_2\text{O}$; sol. in $\text{H}_2\text{C}_2\text{O}_4$ +Aq.	
Fluoride	AlF_3 , <i>aluminium fluoride</i> . White, very obtuse, rhombohedral cryst.; insol. in water, acids or alkalies; only sl. attacked by hot concd. H_2SO_4 ; volatile at bright red heat; M. P. 1040° ; sp. gr. 3. $3\text{AlF}_3\cdot 2\text{HF}\cdot 5\text{H}_2\text{O}$, <i>acid aluminium fluoride</i> . Cryst. masses; sl. sol. in water. $\text{AlF}_3\cdot 3\text{NaF}$, <i>aluminium sodium fluoride, cryolite, cryolith, ice spar, ice stone</i> . White solid; insol. in water.	$\text{CrF}_3\cdot 9\text{H}_2\text{O}$, <i>chromium fluoride, chromic fluoride</i> . Violet cryst.; very sl. sol. in water; insol. in alcohol; sol. in HCl to a violet soln. and in KOH+Aq to a green soln. CrF_3 , <i>anhydrous chromic fluoride</i> . Fine, cryst., green powder or lustrous, dark green octahedra; sol. in water; melts at a high temp. and sublimes at very high temp.; M. P. $>1000^\circ$; sp. gr. 3.8.	$\text{FeF}_2\cdot 8\text{H}_2\text{O}$, <i>iron fluoride, ferrous fluoride</i> . White, right-angled tablets or green prisms; sl. sol. in water, more easily in HF+Aq. FeF_3 , <i>anhydrous ferrous fluoride</i> . White powder or small cryst., sometimes green, but turn white when heated; sl. sol. in water; insol. in alcohol; sl. sol. in hot HCl; sol. in HNO_3 , sl. in cold, easily in hot; decomp. by H_2SO_4 ; sp. gr. 4.	$2\text{FeF}_3\cdot 9\text{H}_2\text{O}$, <i>iron fluoride, ferric fluoride</i> . Colorless or pale yellow cryst.; sl. sol. in water, more in hot than in cold; insol. in alcohol. FeF_3 , <i>anhydrous ferric fluoride</i> . Colorless cubes; sl. sol. in water or mineral acids; insol. in alcohol; melts more easily than AlF_3 and sublimes; sp. gr. 3.2.
Hydride	Unknown.	Unknown.	Unknown.	Unknown.
Hydroxide	$\text{AlO}_2\cdot\text{H}_2\text{O}$, <i>aluminium hydroxide, aluminium hydrate, bauxite, hydrated alumina</i> . White, odorless, tasteless, astringent, amorph. powder; gelatinous when pptd.; nearly insol. in water or H_2CO_3 ; easily sol. in acids when freshly pptd., but solubility diminishes on standing; easily sol. in KOH+Aq or NaOH+Aq, with formation of sol. K or Na aluminates; sl. sol. in NH_4OH when freshly pptd., but the presence of NH_4 salts diminishes its solubility; heating or exposing to air renders the hydroxide less sol.; heated to redness it loses all its hydrate water, contracts considerably and leaves Al_2O_3 . A cryst. variety	$\text{CrO}_2\cdot\text{H}_2\text{O}$, <i>chromium hydroxide, chromium hydroxide, chromium hydrate, chromous hydrate</i> . Brownish yellow, amorph. powder that oxidizes easily in air and turns brown; decomp. by water, especially if hot; nearly insol. in dil. acids; slowly sol. in concd. acids. $\text{CrO}_3\cdot\text{H}_2\text{O}$, <i>chromium hydroxide, chromic hydroxide, chromium hydrate, chromic hydrate</i> . Green, amorph. powder; gelatinous when pptd.; insol. in water; easily sol. in acids; somewhat sol. in excess of cold NH_4OH to a violet-colored soln. but reprecipitates on boiling; easily sol. in cold KOH+Aq or NaOH+Aq, but reprecipitates on boiling;	$\text{FeO}\cdot\text{H}_2\text{O}$, <i>iron hydroxide, ferrous hydroxide, iron hydrate, ferrous hydrate</i> . White ppt. if air is excluded, but turns green rapidly and then oxidizes easily to brown ferric hydroxide; insol. in water; sol. in acids.	$\text{FeO}_2\cdot\text{H}_2\text{O}$, <i>iron hydroxide, ferric hydroxide, iron hydrate, ferric hydrate, Nankin yellow, yellow Nankin</i> . Reddish brown, gelatinous ppt.; amorph. powder or lumps when dry; insol. in water; generally insol. in salt solns.; sol. in acids; changed to the oxide, Fe_2O_3 , when heated.

Al, Cr, Fe, Co, Ni, Mn, Zn GROUP

Cobalt	Nickel	Manganese	Zinc
CoF₂·2H₂O, <i>cobalt fluoride, cobaltous fluoride</i>. Rose-red, cryst. crusts; sparingly sol. in water; decomp. by much boiling water to Co oxyfluoride; sol. in HF+Aq and in mineral acids. CoF₂, <i>anhydrous cobaltous fluoride</i>. Sl. sol. in water; insol. in alcohol; sl. attacked by mineral acids; sp. gr. 4.4.	NiF₂·2H₂O, <i>nickel fluoride, nickelous fluoride</i>. Green cryst. crusts; sparingly sol. in water, with decomp.; sol. in acids, even HF+Aq. NiF₂, <i>anhydrous nickelous fluoride</i>. Insol. in water, alcohol or acids; sp. gr. 4.6.	MnF₂, <i>manganese fluoride, manganous fluoride</i>. Amethyst-colored, cryst. powder or small reddish needles; sol. in HF+Aq. Mn₂F₆, <i>manganese sesquifluoride</i>. Dark red-brown, transparent prisms; decomp. by water; M. P. 856°; sp. gr. 3.9.	ZnF₂·4H₂O, <i>zinc fluoride</i>. Rhombic cryst.; sl. sol. in water, containing HF, HCl or HNO₃; easily sol. in NH₄OH. ZnF₂, <i>anhydrous zinc fluoride</i>. Colorless, lustrous needles; sl. sol. in cold water, more easily in hot; insol. in alcohol; sol. in boiling mineral acids; M. P. 872°; sp. gr. 4.8.
Unknown.	Unknown.	Unknown.	Unknown.
CoO·H₂, <i>cobalt hydroxide, cobaltous hydroxide, cobalt hydrate, cobaltous hydrate</i>. Rose-red, cryst. powder, turns brown on exposure to air; NaOH+Aq or KOH+Aq ppts. from a Co soln. a blue basic salt that changes to the red CoO·H₂ on standing or boiling; oxidizes in air to brown cobaltic hydroxide; insol. in water or NH₄OH; sol. in acids, even HC₂H₃O₂; sp. gr. 3.6. CoO₂·H₂, <i>cobalt hydroxide, cobaltic hydroxide, cobalt hydrate, cobaltic hydrate</i>. Dark brown, amorph. powder; insol. in water or NH₄OH; sol. in acids.	NiO·H₂, <i>nickel hydroxide, nickelous hydroxide, nickel hydrate, nickelous hydrate</i>. Green, cryst. powder or apple-green, gelatinous ppt.; insol. in water; sol. in acids, NH₄OH and solns. of NH₄ salts. NiO₂·H₂, <i>nickel hydroxide, nickelic hydroxide, nickel hydrate, nickelic hydrate</i>. Black powder; insol. in water; sol. in acids, forming nickelous salts; sol. in NH₄OH or solns. of NH₄ salts.	MnO·H₂, <i>manganese hydroxide, manganous hydroxide, manganese hydrate, manganous hydrate</i>. White powder or flocculent ppt.; insol. in water or NH₄OH; somewhat sol. in NH₄Cl+Aq; sol. in acids; oxidizes on exposure to air to dark brown MnO₂·H₂. MnO₂·H₂, <i>manganese hydroxide, manganic hydroxide, manganese hydrate, manganic hydrate</i>. Dark brown, amorph. powder; insol. in water; sol. in HCl, hot HNO₃ or hot, concd. H₂SO₄; insol. in dil. H₂SO₄.	ZnO·H₂, <i>zinc hydroxide, zinc hydrate, zinc oxide, hydrated zinc oxide</i>. White, gelatinous ppt. or amorph. powder; insol. in water; sol. in excess of NaOH+Aq or KOH+Aq with formation of sol. Na or K zincate, from which the hydroxide is reprecipitated on boiling; sol. in NH₄OH, NH₄Cl+Aq and in acids; decomp. at 125°; sp. gr. 3.

Ferri-
cyanide
Cont.

Fluoride

Hydride

Hydroxide

Al, Cr, Fe, Co, Ni, Mn, Zn GROUP

	Aluminium	Chromium	Iron(ferrous)	Iron(ferric)
Hydroxide <i>Cont.</i>	is found occasionally as hexagonal, fibrous cryst.; less sol. than the amorph. form.	the presence of $\text{NH}_4\text{Cl} + \text{Aq}$ has no influence on the solubility of the ppt.		
Hypo- chlorite	Unknown.	Unknown.	Unknown.	Unknown.
Hypo- phos- phite	$\text{Al}_2(\text{H}_2\text{PO}_3)_3$, <i>aluminium hypophosphite</i> . White, lustrous powder or lumps; easily sol. in water; not deliq.	$\text{Cr}_2\text{O}(\text{H}_2\text{PO}_3)_4 \cdot 4\text{H}_2\text{O}$, <i>chromium hypophosphite</i> . Dark green, amorph. powder; sol. in water; at 100° it loses much of its cryst. water and becomes insol.	$\text{Fe}(\text{H}_2\text{PO}_3)_2 \cdot 6\text{H}_2\text{O}$, <i>iron hypophosphite, ferrous hypophosphite</i> . Large, green octahedral cryst.; sol. in water.	$\text{Fe}(\text{H}_2\text{PO}_3)_3$, <i>iron hypophosphite, ferric hypophosphite</i> . White or grayish white; sl. sol. in water; decomp. by boiling; sl. sol. in $\text{H}_2\text{PO}_4 + \text{Aq}$ and mineral acids; decomp. by heat.
Iodate	$\text{Al}(\text{IO}_3)_3$, (?) <i>aluminium iodate</i> . Deliq.	$\text{Cr}(\text{IO}_3)_3$, (?) <i>chromium iodate, chromic iodate</i> . Brown powder.	$\text{Fe}(\text{IO}_3)_2 \cdot \text{H}_2\text{O}$, <i>iron iodate, ferrous iodate</i> . Reddish powder; sl. sol. in water; more sol. in $\text{FeSO}_4 + \text{Aq}$; decomp. when heated.	$\text{Fe}_2\text{O}_3 \cdot 2\text{I}_2\text{O}_5 \cdot 8\text{H}_2\text{O}$, <i>iron iodate, ferric iodate</i> . Yellowish white powder; insol. in water; sl. sol. in HNO_3 ; sol. in $\text{FeCl}_3 + \text{Aq}$; decomp. by heat.
Iodide	AlI_3 , <i>aluminium iodide</i> . Colorless or white, deliq., tabular cryst.; fumes in air; sol. in water, with production of heat; sol. in alcohol or CS_2 ; absorbs NH_3 ; decomp. by heat; M. P. 191° ; B. P. 360° ; the vapor burns with an orange-red flame; p. gr. 3.9.	CrI_3 , <i>chromium iodide, chromous iodide</i> . White salt; easily sol. in water to a blue liquid. CrI_3 , <i>chromium iodide, chromic iodide</i> . Insol. in cold, sol. in hot water; salt does not cryst. from aq. soln.	$\text{FeI}_2 \cdot 5\text{H}_2\text{O}$, <i>iron iodide, ferrous iodide</i> . Dark brownish green, deliq. cryst.; sol. in water or alcohol; oxidizes easily to the oxyiodide. FeI_2 , <i>anhydrous ferrous iodide</i> . Grayish black, very deliq., cryst. mass; sol. in water, with partial decomp. to a blue liquid; M. P. 177° .	FeI_3 , <i>iron iodide, ferric iodide</i> . Has never been isolated; known only in soln. of I_2 in $\text{FeI}_2 + \text{Aq}$.

Cobalt	Nickel	Manganese	Zinc	Hydroxide Cont.
Unknown.	Unknown.	Unknown.	Zn(OCI)₂ , <i>zinc hypochlorite</i> . Known only in soln., which is less stable than Ca(OCI)₂ soln. and decomp. into ZnCl₂ or zinc oxychloride and O₂ .	Hypo-chlorite
Co(H₂PO₃)₂·6H₂O , <i>cobalt hypophosphite, cobaltous hypophosphite</i> . Red, efflor., octahedral cryst.; easily sol. in water; decomp. by heat.	Ni(H₂PO₃)₂·6H₂O , <i>nickel hypophosphite, nickelous hypophosphite</i> . Regular, efflor., cryst.; sol. in water; decomp. by heat.	Mn(H₂PO₃)₂·H₂O , <i>manganese hypophosphite, manganous hypophosphite</i> . Permanent, small, rose-red, lustrous cryst.; very sol. in water.	Zn(H₂PO₃)₂·H₂O , <i>zinc hypophosphite</i> . Permanent, rhombic cryst.; sol. in water.	Hypo-phosphite
Co(IO₃)₂·2H₂O , <i>cobalt iodate, cobaltous iodate</i> . Violet-colored, cryst. crusts; sl. sol. in water, 1 g. in 100 g. of soln. at 18°, 0.7 g. at 100°; sol. in NH₄OH to red-brown soln.; loses its cryst. water at 200° and decomp. at red heat to I₂ , O₂ and Co₂O₃ .	Ni(IO₃)₂·H₂O , <i>nickel iodate, nickelous iodate</i> . Green, cryst. powder; sl. sol. in water; sol. in NH₄OH , HNO₃ or dil. H₂SO₄ ; loses its cryst. water at 100° and at higher temp. decomp. to NiO and I₂ .	Mn(IO₃)₂ , <i>manganese iodate, manganous iodate</i> . Red, cryst. powder or small, lustrous cryst.; very sl. sol. in water; insol. in NH₄OH or HNO₃ , even when hot; decomp. when heated to Mn₂O₄ and I₂ .	Zn(IO₃)₂·2H₂O , <i>zinc iodate</i> . White, cryst. powder; sl. sol. in water; sol. in NH₄OH or HNO₃ ; decomp. when heated; sp. gr. 4.9.	Iodate
CoI₂·6H₂O , <i>cobalt iodide, cobaltous iodide</i> . Brownish red, broad, hexagonal, prismatic, deliq. cryst.; easily sol. in water. CoI₂·2H₂O , <i>cobaltous iodide</i> . Very deliq., green cryst.; sol. in water. CoI₂ , <i>anhydrous cobaltous iodide</i> . Grayish green to black, graphite-like masses; sol. in water to a green or brown soln., probably 58 g. in 100 g. of soln. at 0°, 65 g. at 20°, 80 g. at 80°; sol. in alcohol; sp. gr. 5.7.	NiI₂·6H₂O , <i>nickel iodide, nickelous iodide</i> . Blue-green, very deliq., prismatic cryst.; easily sol. in water. NiI₂ , <i>anhydrous nickelous iodide</i> . Black, tabular cryst., with metallic luster; sublimes without melting; deliq. in moist air; sol. in a little water to a red-brown soln., in much water to a green soln., 55 g. in 100 g. of soln. at 0°, 60 g. at 20°, 65 g. at 90°; partly decomp. by heat.	MnI₂·4H₂O , <i>manganese iodide, manganous iodide</i> . Rose-red, very deliq. tabular cryst. that turn brown when exposed to the air and light; sol. in water; when heated in oxygen it burns easily and evolves iodine vapors. MnI₂ , <i>anhydrous manganous iodide</i> . Brown, deliq., fused, cryst. masses; sol. in water, with decomp.; also decomp. by heat.	ZnI₂ , <i>zinc iodide</i> . Hygroscopic, white, cryst. powder or small, cube-like octahedra; sharp, saline taste; easily sol. in water, 81 g. in 100 g. of soln. at 0°, 83 g. at 22°. 84 g. at 100°; sol. in alcohol; decomp. by heat to ZnO and I₂ ; M. P. c. 446°; B. P. c. 624°; sp. gr. 4.6.	Iodide

Al, Cr, Fe, Co, Ni, Mn, Zn GROUP

	Aluminium	Chromium	Iron(ferrous)	Iron(ferric)
Manganate	Unknown. $\text{Al}(\text{MnO}_4)_3$, <i>aluminium permanganate</i> . Cannot be obtained free, as it is extremely unstable.	Unknown. Unknown.	FeMnO_3 , <i>iron manganate, ferrous manganate, bixbyite</i> . Unknown.	Fe_2MnO_4 , <i>iron manganate, ferric manganate, jacobsonite</i> . Unknown.
Molybdate	$5\text{Al}_2\text{O}_3 \cdot 2\text{MoO}_3 \cdot x\text{H}_2\text{O}$, (?) <i>aluminium molybdate</i> . White, amorph. powder of doubtful or complex compn.; insol. in water.	$\text{Cr}_2(\text{MoO}_4)_3$, (?) <i>chromium molybdate, chromic molybdate</i> . Amorph. powder of complex compn.; insol. in water, but sol. in acids and in $(\text{NH}_4)_2\text{MoO}_4 + \text{Aq}$.	FeMoO_4 , <i>iron molybdate, ferrous molybdate</i> . Dark brown, monoclinic prisms; insol. in water.	$\text{Fe}_2\text{O}_3 \cdot 4\text{MoO}_3 \cdot 7\text{H}_2\text{O}$, <i>iron molybdate, ferric molybdate</i> . Voluminous, yellow ppt.; nearly insol. in water; slowly sol. in cold, easily in hot HCl or HNO_3 ; generally decomp. by dil. acids, with formation of MoO_3 ; sol. in $\text{FeCl}_3 + \text{Aq}$ or $(\text{NH}_4)_2\text{MoO}_4 + \text{Aq}$.
Nitrate	$\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$, <i>aluminium nitrate</i> . Light, very deliq., broad, oblique, prismatic cryst.; decomp. at 150° ; easily sol. in water, alcohol and HNO_3 ; melts in its cryst. water at 73° . $2\text{Al}_2\text{O}_3 \cdot 3\text{N}_2\text{O}_5$. $3\text{H}_2\text{O}$, <i>basic aluminium nitrate</i> . Sl. sol. in water.	$\text{Cr}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$, <i>chromium nitrate, chromic nitrate</i> . Bluish green soln. or dark purple, almost black, oblique, rhombic prisms; very sol. in water or alcohol; melts in its cryst. water at 37° to a green liquid which boils at 125° . $\text{Cr}(\text{NO}_3)_2\text{OH}$ and $\text{CrNO}_3(\text{OH})_2$, <i>basic chromic nitrates</i> . Green, amorph. powders; sol. in water.	$\text{Fe}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$, <i>iron nitrate, ferrous nitrate</i> . Cryst. that are stable when kept in mother liquor; sol. in water, 41 g. of anhydrous salt in 100 g. of soln. at 0° , 45 g. at 18° , 62 g. at 60° ; the soln. decomp. when heated.	$\text{Fe}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$, <i>iron nitrate, ferric nitrate</i> . Nearly colorless, sl. deliq., monoclinic cryst.; very sol. in water or alcohol; very sl. sol. in cold or concd. HNO_3 ; melts at 47° in its cryst. water; acid begins to come off at 100° ; boils at 125° ; completely decomp. at red heat. $\text{Fe}(\text{NO}_3)_3 \cdot 6\text{H}_2\text{O}$, <i>ferric nitrate</i> . Colorless or pale violet-blue, deliq., cubical cryst.; sol. in water; M. P. 35° . $\text{Fe}(\text{NO}_3)_3 \cdot \text{FeO}_3\text{H}_3$, <i>basic ferric nitrate</i> . Brown powder of variable compn.; nearly insol. in water.
Nitrite	Unknown.	Unknown.	Unknown.	Unknown.

Cobalt	Nickel	Manganese	Zinc	Manganate
Unknown.	Unknown.	Unknown.	Unknown.	
Unknown.	Unknown.	Unknown.	Zn(MnO₄)₂·6H₂O , <i>zinc permanganate</i> . Violet-brown or almost black, hygroscopic, cryst. granules; resembles KMnO ₄ ; sol. in water.	
CoMoO₄ , <i>cobalt molybdate, cobaltous molybdate</i> . Small, indefinite, grayish green cryst.; insol. in water, decomp. by alkalies or strong acids.	NiMoO₄ , (?) <i>nickel molybdate, nickelous molybdate</i> . Green prisms of doubtful compn.; sl. sol. in water.	MnMoO₄·H₂O , <i>manganese molybdate, manganous molybdate</i> . Heavy, white powder or microscopic, prismatic tablets; sometimes dirty yellow, cryst. masses; sol. in water and in dil. acids; decomp. by alkalies.	ZnMoO₄·H₂O , <i>zinc molybdate</i> . Microscopic needles; sl. sol. in water; easily sol. in dil. acids.	Molybdate
Co(NO₃)₂·6H₂O , <i>cobalt nitrate, cobaltous nitrate</i> . Red, prismatic or monoclinic, tabular, deliq. cryst.; easily sol. in water, 45 g. of the anhydrous salt in 100 g. of soln. at 0°, 50 g. at 18°, 77 g. at 91°; easily sol. in alcohol; melts in its cryst. water at 50°, the liquid becoming thick and green when heated, and decomp. at higher temp., giving H ₂ O, N oxides and black Co ₃ O ₄ ; sp. gr. 1.9. <i>Basic cobaltous nitrate</i> . Blue, amorph. powder of variable compn.; turns green or yellow in air; insol. in water; sol. in HNO ₃ .	Ni(NO₃)₂·6H₂O , <i>nickel nitrate, nickelous nitrate</i> . Emerald-green, monoclinic prisms; deliq. in moist air; easily sol. in water, 44 g. of the anhydrous salt in 100 g. of soln. at 0°, 49 g. at 20°, 77 g. at 95°; sol. in NH ₄ OH or dil. alcohol; insol. in abs. alcohol; melts at 57°; boils at 137°, remaining clear until half the cryst. water is gone, when acid fumes are evolved, and a yellowish green mixture of NiO and an insol. basic salt is left; sp. gr. 2. <i>Basic nickel nitrate</i> . Whitish amorph. powder of variable compn.; insol. in water.	Mn(NO₃)₂·6H₂O , <i>manganese nitrate, manganous nitrate</i> . Small, monoclinic, colorless or white, deliq. cryst.; easily sol. in water, 50 g. of the anhydrous salt in 100 g. of soln. at 0°, 57 g. at 18°, 76 g. at 35°; easily sol. in alcohol; melts in its cryst. water at 26°; boils at 130°; decomp. at high temp., giving Mn oxides; sp. gr. 1.8. <i>Basic manganous nitrate</i> . Sol. in water.	Zn(NO₃)₂·6H₂O , <i>zinc nitrate</i> . Colorless, four-sided, deliq. prisms; very sol. in water, 48 g. in 100 g. of soln. at 0°, 53 g. at 18°, 77 g. at 45°; very sol. in alcohol; melts in its cryst. water at 36°; boils at 131°; Zn(NO ₃) ₂ +Aq when heated soon decomp., with formation of an insol. basic Zn nitrate; sp. gr. 2.	Nitrate
Co(NO₂)₂ , (?) <i>cobalt nitrite, cobaltous nitrite</i> . Known only in soln. Co(NO₂)₂·3KNO₃ , <i>cobaltic potassium</i>	Ni(NO₂)₂ , <i>nickel nitrite, nickelous nitrite</i> . Reddish yellow, cryst. crusts; stable in air; sol. in water	Mn(NO₂)₂ , (?) <i>manganese nitrite, manganous nitrite</i> . Known only in soln.	Zn(NO₂)₂·3H₂O , <i>zinc nitrite</i> . Deliq., indefinite cryst., which decomp. at 100°; sol. in water or alcohol.	Nitrite

Aluminium	Chromium	Iron(ferrous)	Iron(ferric)
$\text{Al}_2(\text{C}_2\text{O}_4)_3 \cdot 4\text{H}_2\text{O}$, aluminium oxalate. White powder; insol. in water; sol. in acids.	$\text{Cr}_2(\text{C}_2\text{O}_4)_3 \cdot 4\text{H}_2\text{O}$, chromium oxalate, chromic oxalate. Green scales; sparingly sol. in water; readily sol. in acids.	$\text{FeC}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$, iron oxalate, ferrous oxalate. Pale yellow, odorless, cryst. powder; insol. in water; sol. in cold HCl or in hot, dil. HNO_3 .	$\text{Fe}_2(\text{C}_2\text{O}_4)_3$, iron oxalate, ferric oxalate. Light green scales; permanent in the dark, but change to yellow ferrous oxalate on exposure to light; insol. in water; sol. in acids.
Al_2O_3 , aluminium oxide, alumina, corundum, emery, sapphire, ruby, topaz, emerald, amethyst, gibbsite, hydrargillite, rock alum, aloxite, diaspor, alundum, borolon, adamite, borocarbene. White, soft, amorph. powder; cakes when strongly heated, and becomes nearly as hard as corundum; insol. in water; sol. in acids; heating renders it more insol.; infusible except in the oxyhydrogen blowpipe. The cryst. variety occurs native in small rhombohedra or hexagonal prisms, colorless when pure, but often beautifully colored by impurities and then suitable for gems; nearly as hard as diamond; insol. in acids; M. P. 2050°; sp. gr. 4.	Cr_2O_3 , chromium oxide, chromic oxide, green oxide of chromium, chrome green, Guignet's green, anadonis green, chrome ochre, chromium sesquioxide, ultramarine green, oil green, green cinnabar, leaf green, emerald green. Bright green, amorph. powder; turns brown when heated; the color varies with the method of preparation; cryst. Cr_2O_3 consists of very dark green, lustrous, hexagonal cryst., as hard as corundum; amorph. Cr_2O_3 is insol. in water and sol. in acids; the ignited or cryst. oxide is nearly insol. in acids, but dissolves in H_2SO_4 by long boiling; M. P. 1900°; sp. gr. 5.2. CrO_2 , chromium oxide, chromium dioxide, chromium	FeO , iron oxide, ferrous oxide. Black powder; insol. in water; easily sol. in HCl or HNO_3 ; less easily sol. in H_2SO_4 ; oxidizes to higher oxides when heated; M. P. 1420°.	Fe_2O_3 , iron oxide, ferric oxide, brown oxide of iron, hematite, rust, rouge, imperial red, scarlet ochre, Paris red, colcothar, jeweller's rouge, polishing crocus, Indian red, iron buff, iron sponge, purple oxide, red iron oxide, red earth, red oxide, red ochre, red stone, red chalk, scarlet red, specular iron, Tuscan red, umber, Vandyke brown, Venetian red, bloodstone, heliotrope, kidney ore, micaeous iron ore, iron glance, red bole, red crocus, English red, angel red, chemical red, iron red, Berlin red, iron minium, stone red, crocus, American sienna, mineral purple, Prussian red, Italian red, mineral rouge, blood red, brown red, iron saffron. Steel-gray

Cobalt	Nickel	Manganese	Zinc	Nitrite Cont.
<i>nitrite, cobalt yellow, potassium cobaltinitrite, yellow cobalt, Fischer's salt. Bright yellow powder, consisting of small four-sided prisms; very sl. sol. in water; insol. in alcohol; decomp. by HCl and KOH+Aq; sl. sol. in free $HC_2H_3O_2$, but insol. in presence of much concd. KNO_2+Aq.</i>	to a green soln., which decomp. when heated; sol. in alcohol.			
$CoC_2O_4 \cdot 2H_2O$, cobalt oxalate, cobaltous oxalate. Light pink powder; insol. in water; sol. in acids.	$NiC_2O_4 \cdot 2H_2O$, nickel oxalate, nickelous oxalate. Light green powder; insol. in water; sol. in acids.	$MnC_2O_4 \cdot 2H_2O$, manganese oxalate, manganous oxalate. White, cryst. powder; sparingly sol. in water; readily sol. in acids; decomp. at 150° into CO , CO_2 and MnO .	$ZnC_2O_4 \cdot 2H_2O$, zinc oxalate. White powder; insol. in water; sol. in acids.	Oxalate
CoO, cobalt oxide, cobaltous oxide, cobalt monoxide, zaffre, safflower. Yellow-green or greenish-brown, sl. hygroscopic powder; not magnetic; insol. in water or NH_4OH ; easily sol. in dil. or concd. HCl or HNO_3 ; dil. HCl gives a rose-red soln., concd. a deep blue; HNO_3 gives a rose-red soln.; slowly sol. in cold, but easily sol. in hot, dil. H_2SO_4 to a rose-red soln.; sol. in hot, concd. H_2SO_4 to a deep blue soln.; sol. in dil. $HC_2H_3O_2$ or hot $NaOH$ + Aq ; unchanged in air, but oxidizes to Co_2O_3 when strongly heated; sp. gr. 5.7.	NiO, nickel oxide, nickelous oxide, nickel monoxide, green nickel oxide, Bunsenite. Green, amorph. powder or grayish green, microscopic, regular, octahedral cryst.; turns yellow when heated; insol. in water; the amorph. form is easily sol. in strong acids; the cryst. form is barely attacked by acids; insol. in $HC_2H_3O_2$ or $NaOH$ + Aq ; slowly sol. in NH_4OH to a violet soln.; heated to c. 400° it oxidizes to Ni_2O_3 ; sp. gr. 7.4.	MnO, manganese oxide, manganous oxide, manganese monoxide, manganosite. Grass-green powder or lustrous, diamond-like, green, regular octahedra; insol. in water; easily sol. in acids or NH_4Cl + Aq ; oxidizes to Mn_2O_4 , when heated in air; melts at white heat in absence of air; M. P. 1650° ; sp. gr. 5.2.	ZnO, zinc oxide, flowers of zinc, zinc white, philosopher's wool, Chinese white, zincite, red zinc oxide, French zinc, French zinc oxide, permanent white, snow white. Ordinarily a white, amorph. powder that turns yellow when heated, but turns white again when cooled; occasionally found as very lustrous, white, hexagonal pyramids that change color like the amorph. form when heated; absorbs CO_2 from the air; is not decomp. at c. 1750° ; insol. in water; easily sol. in dil. acids, even after ignition; sol. even in H_2SO_4 and in H_2CO_3 ; sol. in hot NH_4Cl + Aq ; in KOH + Aq , $NaOH$ + Aq and NH_4OH it dissolves easily when moist, less easily after igni-	Oxide
Co_2O_3, cobalt oxide, cobaltic oxide, cobalt peroxide, cobalt black, cobalt sesquioxide, cobalt red, cobalt rose. Steel gray to	Ni_2O_3, nickel oxide, nickelic oxide, nickel peroxide, black nickel oxide, nickel black, nickel sesquioxide. Grayish black powder; insol. in water; sol. in HCl , with evolution of Cl_2 and in H_2SO_4 or HNO_3 , with evolution of O_2 , nickelous salts	Mn_2O_3, manganese oxide, manganic oxide. Black powder; occasionally brownish black, very hard, lustrous, quadratic, octahedra; insol. in water or NH_4Cl + Aq ; sol. in cold HCl to a brown soln. and in hot, dil. or concd. H_2SO_4 to a reddish soln.; decomp. by hot HNO_3 to MnO , which dissolves, and MnO_2 , which ppts.; manganous salts are generally		

Al, Cr, Fe, Co, Ni, Mn, Zn GROUP

	Aluminium	Chromium	Iron(ferrous)	Iron(ferric)
Oxide Cont.		tetroxide, brown oxide of chromium, chromate of chromium. Dark gray, almost black, amorph. powder; very hygroscopic; insol. in water, but decomp. thereby into CrO_3 and Cr_2O_3; easily sol. in dil. acids, if freshly pptd.; loses O_2 at 300°. CrO_3, chromium oxide, chromium trioxide, chromic anhydride, red oxide of chromium, "chromic acid," chromic acid anhydride. Long, red, nondeliq., caustic, astringent, very lustrous needles; dark red, flaky, cryst. powder; easily sol. in water to an acid reacting soln., containing H_2CrO_4, 62 g. in 100 g. of soln. at 0° and 18°, 68 g. at 100°; darkens when heated; M. P. c. 190° with decomp.; strong oxidizing agent, yielding Cr salts and free oxygen; sol. in H_2SO_4; decomp. alcohol; sp. gr. 2.7.		or black, cryst. masses or dense, red brown powder; insol. in water; slowly sol. in acids; sol. with considerable difficulty, if the oxide has been heated; HCl is the best solvent; M. P. 1560° with decomp.; sp. gr. 5.1. Fe_2O_3, iron oxide, ferrous-ferric oxide, black oxide of iron, magnetic oxide of iron, magnetite, black ferric oxide, black rouge, iron ethiops, lodestone. Iron-black, cryst. masses or brownish black powder; magnetic; insol. in water or HNO_3; sol. in HCl. $\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$, hydrated ferric oxide, bog iron ore, brown hematite, brown iron ore, limonite, mountain brown ore, valley brown ore, black iron oxide, magnetic ferric oxide. Similar to Fe_2O_3.
Phosphate	$\text{Al}_2(\text{PO}_4)_3 \cdot x\text{H}_2\text{O}$, aluminium phosphate, normal aluminium phosphate, neutral aluminium phosphate, trialu-	$\text{Cr}_3(\text{PO}_4)_2 \cdot \text{H}_2\text{O}$, chromium phosphate, chromous phosphate. Blue, amorph. powder that quickly turns	$\text{Fe}_2(\text{PO}_4)_2 \cdot 8\text{H}_2\text{O}$, iron phosphate, ferrous phosphate, normal ferrous phosphate, neutral ferrous phosphate,	$\text{Fe}_2(\text{PO}_4)_3 \cdot 8\text{H}_2\text{O}$, iron phosphate, ferric phosphate, normal ferric phosphate, neutral ferric phosphate, tri-

Al, Cr, Fe, Co, Ni, Mn, Zn GROUP

Cobalt	Nickel	Manganese	Zinc	Oxide Cont
brownish black mass or a blue powder; insol. in water; sol. in most acids, even in the cold, cobaltous salts being formed; oxidizes to Co_2O_3 when heated; sp. gr. 5.1. Co_2O_3, <i>cobalt oxide, cobalto-cobaltic oxide, black oxide of cobalt, tricobalt tetroxide</i>. Lustrous, metal-like, grayish black, microscopic octahedra or black amorph., hygroscopic powder; insol. in hot concd. HCl, HNO_3 or aqua regia; slowly sol. in hot, concd. H_2SO_4; sp. gr. 6.	being formed; sol. in NH_4OH; decomp. to NiO at c. 600°; sp. gr. 4.8. Ni_3O_4, <i>nickel oxide, nickel-nickelic oxide, trinickel tetroxide</i>. Gray, metal-like, non-magnetic solid; insol. in water; sol. in acids.	formed; decomp. by heat to O_2 and Mn_2O_3; sol. in concd. acids; sp. gr. 4.5. Mn_2O_3, <i>manganese oxide, manganomanganic oxide, red oxide of manganese, hausmannite, trimanganese tetroxide</i>. Reddish brown powder or brown, tetragonal cryst.; insol. in water; sol. in hot, dil. or in cold concd. HCl, Cl_2 being evolved in the latter case; sol. in H_2SO_4; with hot, dil. HNO_3 sol. $\text{Mn}(\text{NO}_3)_2$ and insol. MnO_2 are formed; sp. gr. 4.7. MnO_2, <i>manganese oxide, manganese peroxide, manganese dioxide, black oxide of manganese, pyrolusite, battery manganese, bog manganese, glass makers soap, wad, polianite, manganese black</i>. Steel-gray lumps with metallic luster or brownish black to black powder, sometimes hard, and cryst., sometimes soft, fine and amorph.; occasionally brittle, rhombic prisms; insol. in water or $\text{NH}_4\text{Cl} + \text{Aq}$; insol. in dil., but sl. sol. in cold, concd. HCl; very slowly sol. in concd. H_2SO_4, with evolution of O_2; sol. in aqua regia; changes to Mn_2O_3 at red heat, to Mn_3O_4 at white heat; sp. gr. 5.	tion; sp. gr. 5.4.	
$\text{Co}_3(\text{PO}_4)_2 \cdot 2\text{H}_2\text{O}$, <i>cobalt phosphate, cobaltous phosphate, normal cobaltous phosphate, neutral cobaltous</i>	$\text{Ni}_3(\text{PO}_4)_2 \cdot 7\text{H}_2\text{O}$, <i>nickel phosphate, nickelous phosphate, normal nickelous phosphate, neutral nickelous</i>	$\text{Mn}_3(\text{PO}_4)_2 \cdot 7\text{H}_2\text{O}$, <i>manganese phosphate, manganous phosphate, normal manganous phosphate, neutral</i>	$\text{Zn}_3(\text{PO}_4)_2 \cdot 4\text{H}_2\text{O}$, <i>zinc phosphate, normal zinc phosphate, neutral zinc phosphate, trizinc orthophosphate,</i>	Phosphate

Al, Cr, Fe, Co, Ni, Mn, Zn GROUP

Phosphate
Cont.

Aluminium	Chromium	Iron(ferrous)	Iron(ferric)
<i>minium orthophosphate, tertiary aluminium phosphate.</i> White, loose, amorph. powder or hexagonal prisms; does not fuse even at white heat; the cryst. is insol. in concd. HCl or HNO₃, and sl. attacked by hot, concd. H₂SO₄; the amorph. variety is easily sol. in mineral acids, insol. in HC₂H₃O₂, easily sol. in NH₄OH or KOH+Aq, but is reprecipitated from the latter by NH₄Cl+Aq; sol. in fused Na₂CO₃.	green in air; easily sol. in acids. Cr₂(PO₄)₃, <i>chromium phosphate, chromic phosphate, normal chromic phosphate, neutral chromic phosphate, trichromic orthophosphate, tertiary chromic phosphate.</i> Two forms are known. Cr₂(PO₄)₃·12H₂O, <i>violet form.</i> Voluminous, violet, amorph. powder that becomes crystalline on standing; is turned green by concd. H₂SO₄ or HNO₃; very sl. sol. in hot water; loses 7H₂O at 100°, becoming green. Cr₂(PO₄)₃·6H₂O, <i>green form, Plessy's green.</i> Green, amorph. powder; very sl. sol. in water; insol. in HC₂H₃O₂; easily sol. in mineral acids and in NaOH+Aq or KOH+Aq.	<i>triferrous orthophosphate, tertiary ferrous phosphate, vivianite.</i> Small, indigo blue, lustrous, monoclinic cryst. or grayish to bluish, amorph. powder; sometimes white at first, but rapidly turns blue in air; insol. in water; sol. in acids.	<i>ferric orthophosphate, tertiary ferric phosphate.</i> Yellowish white, amorph. or grayish white, cryst. powder; insol. in water, H₂PO₄ or HC₂H₃O₂; easily sol. in dil. mineral acids.
Unknown.	Cr₂H₂(HPO₄)₄·16H₂O, <i>chromium phosphate, acid chromium phosphate, dichromium orthophosphate, secondary chromium phosphate.</i> Cryst.; sol. in water.	FeHPO₄·H₂O, <i>iron phosphate, acid ferrous phosphate, diferrous orthophosphate, secondary ferrous phosphate.</i> Small, colorless needles.	Unknown.
Al₂(H₂PO₄)₃, <i>aluminium phosphate, acid aluminium phosphate, monoaluminium orthophosphate, primary aluminium phosphate.</i> Deliq.; completely sol. in a little cold water; a dil. aq. soln., when boiled precipitates. Al₂(PO₄)₃, which	Unknown.	Fe(H₂PO₄)₂·2H₂O, <i>iron phosphate, acid ferrous phosphate, monoferrous orthophosphate, primary ferrous phosphate.</i> White, crystalline meal; oxidizes easily in air; easily sol. in water; not changed by alcohol.	Fe₂(H₂PO₄)₃, <i>iron phosphate, acid ferric phosphate, monoferric orthophosphate, primary ferric phosphate.</i> White powder, reddish, crystalline meal or rhombic tablets; deliquescent in moist air, with darkening of red color.

Cobalt	Nickel	Manganese	Zinc
phosphate, trico- baltous orthophos- phate, tertiary co- baltous phosphate, cobalt blue. Pink or violet-blue, amorph. powder or rose-red octahe- dra; insol. in wa- ter; sol. in mineral acids, even H_2PO_4 ; also sol. in NH_4OH and in solns. of Co salts.	phosphate, trinick- elous orthophos- phate, tertiary nickelous phos- phate. Apple- green, amorph powder or dark green cryst. pow- der; insol. in wa- ter; sol. in acids and in solns. of Ni salts; when heat- ed it turns yellow, then brown.	manganous phos- phate, trimanga- nous orthophos- phate, tertiary manganous phos- phate. White lumps or amorph. powder; very sl. sol. in water or al- cohol; easily sol. in mineral acids and in $\text{HC}_2\text{H}_3\text{O}_2$. $\text{MnPO}_4 \cdot \text{H}_2\text{O}$, man- ganese phosphate, manganic phos- phate, normal manganic phos- phate, neutral manganic phos- phate, trimanganic orthophosphate, tertiary manganic phosphate. Green- ish gray, amorph. powder; insol. in water; sol. in acids.	tertiary zinc phos- phate, hopeite, par- ahopeite. White, amorph. powder or colorless, prismatic cryst.; insol. in wa- ter; easily sol. in acids, NH_4OH and in solns. of NH_4 salts; melts at strong red heat
$\text{CoHPO}_4 \cdot 3\text{H}_2\text{O}$, co- balt phosphate, acid cobaltous phosphate, dico- baltous orthophos- phate, secondary cobaltous phos- phate. Violet-red masses or cryst. tablets; insol. in water; sol. in $\text{H}_2\text{PO}_4 + \text{Aq}$.	Unknown.	$\text{MnHPO}_4 \cdot 3\text{H}_2\text{O}$, manganese phos- phate, acid man- ganous phosphate, dimanganous or- thophosphate, sec- ondary manganous phosphate. Pale red, rhombic, six- sided tablets, with glassy luster; sl. sol. in water or $\text{HC}_2\text{H}_3\text{O}_2$; easily sol. in concd. min- eral acids; decomp. at red heat.	$\text{ZnHPO}_4 \cdot \text{H}_2\text{O}$, zinc phosphate, acid zinc phosphate, di- zinc orthophos- phate, secondary zinc phosphate. Insol. in water; sol. in $\text{H}_2\text{PO}_4 + \text{Aq}$.
$\text{Co}(\text{H}_2\text{PO}_4)_2$, co- balt phosphate, acid cobaltous phosphate, mono- cobaltous ortho- phosphate, primary cobaltous phos- phate. Sol. in water.	Unknown.	$\text{Mn}(\text{H}_2\text{PO}_4)_2$, $2\text{H}_2\text{O}$, manganese phosphate, acid manganous phos- phate, monoman- ganous orthophos- phate, primary manganous phos- phate. Four-sided, deliq. prisms; eas- ily sol. in water, with decomp. to MnHPO_4 ; loses	$\text{Zn}(\text{H}_2\text{PO}_4)_2 \cdot 2\text{H}_2\text{O}$, zinc phosphate, acid zinc phos- phate, monozinc orthophosphate, primary zinc phos- phate. Large, tri- clinic cryst.; near- ly insol. in water, but decomp. thereby.

Phosphate
Cont.

Al, Cr, Fe, Co, Ni, Mn, Zn GROUP

Phosphate
Cont.

Aluminium	Chromium	Iron(ferrous)	Iron(ferric)
re-dissolves on cooling.			
$\text{Al}_2(\text{PO}_3)_3$, <i>aluminium metaphosphate</i> . Insol. in water or concd. acids.	$\text{Cr}_2(\text{PO}_3)_3$, <i>chromic metaphosphate</i> . Green powder or transparent, orthorhombic cryst.; insol. in water or concd. acids.	$\text{Fe}(\text{PO}_3)_2$, (?) <i>ferrous metaphosphate</i> . Sl. sol. in cold, more in hot water; sol. in HCl.	$\text{Fe}_2(\text{PO}_3)_3$, <i>ferric metaphosphate</i> . White powder or transparent, pale yellow, long, orthorhombic prisms; insol. in water or dil. acids; sol. in concd. H_2SO_4 .
$\text{Al}_2(\text{P}_2\text{O}_7)_3 \cdot 10\text{H}_2\text{O}$, <i>aluminium pyrophosphate</i> . White, amorph. powder; insol. in water or $\text{H}_2\text{C}_2\text{O}_4$; sol. in mineral acids, $\text{Na}_2\text{P}_2\text{O}_7 + \text{Aq}$, $\text{KOH} + \text{Aq}$ or NH_4OH .	$\text{Cr}_2(\text{P}_2\text{O}_7)_3$, <i>chromic pyrophosphate</i> . Reddish green, amorph. powder; insol. in water or acids.	$\text{Fe}_2\text{P}_2\text{O}_7$, (?) <i>ferrous pyrophosphate</i> . White, amorph. powder of uncertain compn.; in the air it turns rapidly to green, then brown; insol. in water; sol. in excess of $\text{Na}_2\text{P}_2\text{O}_7 + \text{Aq}$ or $\text{FeSO}_4 + \text{Aq}$.	$\text{Fe}_2(\text{P}_2\text{O}_7)_3 \cdot 9\text{H}_2\text{O}$, <i>ferric pyrophosphate</i> . Yellowish white powder; insol. in water; sol. in acids, $\text{Na}_2\text{P}_2\text{O}_7 + \text{Aq}$ or $\text{FeCl}_3 + \text{Aq}$; a second insol. variety is said to exist.
$x\text{Al}_2\text{O}_3 \cdot y\text{P}_2\text{O}_5 \cdot z\text{H}_2\text{O}$, <i>basic aluminium phosphate</i> . White powder of variable compn.; insol. in water.	Unknown.	$x\text{FeO} \cdot y\text{P}_2\text{O}_5 \cdot z\text{H}_2\text{O}$, <i>basic ferrous phosphate</i> . Sol. in dil. HCl or H_2SO_4 ; decomp. by hot $\text{NaOH} + \text{Aq}$.	$x\text{Fe}_2\text{O}_3 \cdot y\text{P}_2\text{O}_5 \cdot z\text{H}_2\text{O}$, <i>basic ferric phosphate</i> . Red-brown powder; insol. in water; sol. in acids.

Phosphite

AlPO_3 (?) <i>aluminium phosphite</i> . White, amorph. powder; sl. sol. in water.	CrPO_3 , (?) <i>chromic phosphite</i> . Al-most insol. in water.	$\text{FeHPO}_3 \cdot x\text{H}_2\text{O}$, <i>iron phosphite, ferrous phosphite</i> . White to greenish white, amorph. powder; nearly insol. in water.	$\text{Fe}_2(\text{HPO}_3)_3 \cdot 9\text{H}_2\text{O}$, <i>iron phosphite, ferric phosphite</i> . White powder that turns yellow when dried; insol. in water.
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Silicate

$\text{Al}_2(\text{SiO}_3)_3$, <i>aluminium silicate, aluminium metasilicate, kaolin, clay, kaolinite, pencil stone, pyrophyllite, argilla, halloysite, zeolite, neutrolon, porcelain clay, porcelain earth, China clay, terra alba, white bole, Cornish clay, pipe clay</i> .	$2\text{H} \cdot \text{Cr}_2(\text{SiO}_3)_3$, H_2SiO_4 , <i>chromium silicate, dichromium hexahydrotriorthosilicate</i> . Grayish green hydrogel.	Fe_2SiO_4 , <i>iron silicate, ferrous orthosilicate, fayalite</i> . Red-brown powder; insol. in water; gelatinous silicic acid separates when boiled with HCl.	$\text{Fe}_2(\text{SiO}_3)_3$, <i>iron silicate, ferric metasilicate</i> . Occurs native and with other bases, but with varying compn.; gelatinous silicic acid separates when boiled with HCl.
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Cobalt	Nickel	Manganese	Zinc	Phosphate Cont.
$\text{Co}(\text{PO}_3)_2$, <i>cobaltous metaphosphate</i>. Blue amorph. masses; insol. in cold, concd. H_2SO_4; sol. in water only when the salt has been previously treated with H_2SO_4; sol. in concd. NH_4OH. $\text{Co}_2\text{P}_2\text{O}_7$, <i>cobaltous pyrophosphate</i>. Amorph. powder; sol. in NH_4OH or $\text{Na}_4\text{P}_2\text{O}_7 + \text{Aq}$. Unknown.	$\text{Ni}(\text{PO}_3)_2$, <i>nickelous metaphosphate</i>. Greenish yellow, amorph. masses; insol. in water and dil. acids; sol. in concd. H_2SO_4. $\text{Ni}_2\text{P}_2\text{O}_7 \cdot 6\text{H}_2\text{O}$, <i>nickelous pyrophosphate</i>. Bright green, amorph. or cryst. powder; insol. in water; sol. in mineral acids, $\text{Na}_4\text{P}_2\text{O}_7 + \text{Aq}$ or NH_4OH; decomp. by water at 300°. Unknown.	one H_2O at 100°, the other at red heat. $\text{Mn}(\text{PO}_3)_2$, <i>manganous metaphosphate</i>. Reddish white, amorph. powder; insol. in water or dil. acids; sol. in concd. H_2SO_4; melts with difficulty. $\text{Mn}(\text{PO}_3)_2$, <i>manganic metaphosphate</i>. Insol. in water or acids; decomp. by alkalis. $\text{Mn}_2\text{P}_2\text{O}_7 \cdot 3\text{H}_2\text{O}$, <i>manganous pyrophosphate</i>. White, amorph. powder; insol. in water; sol. in $\text{Na}_4\text{P}_2\text{O}_7 + \text{Aq}$. MnHP_2O_7, <i>manganic pyrophosphate</i>. Insol. in water; sol. in concd. H_2SO_4; very sl. sol. in dil., easily in concd. HCl. Unknown.	$\text{Zn}(\text{PO}_3)_2 \cdot 4\text{H}_2\text{O}$, <i>zinc metaphosphate</i>. Small, colorless, transparent cryst.; insol. in water; decomp. by boiling water or hot acids; loses its cryst. water at red heat. $\text{Zn}_2\text{P}_2\text{O}_7$, <i>zinc pyrophosphate</i>. White powder, sometimes voluminous, sometimes cryst.; insol. in water; sol. in acids, NH_4OH, $\text{KOH} + \text{Aq}$ or $\text{Na}_4\text{P}_2\text{O}_7 + \text{Aq}$. $x\text{ZnO} \cdot y\text{P}_2\text{O}_5 \cdot z\text{H}_2\text{O}$, <i>basic zinc phosphate, spencerite</i>. White, amorph. powder; insol. in water.	
$\text{CoHPO}_3 \cdot 2\text{H}_2\text{O}$, <i>cobalt phosphite, cobaltous phosphite</i>. Pale red, amorph. powder; turns blue when heated to 250°, losing its cryst. water; insol. in water.	$2\text{NiHPO}_3 \cdot 7\text{H}_2\text{O}$, <i>nickel phosphite, nickelous phosphite</i>. Green amorph. powder; insol. in water.	$2\text{MnHPO}_3 \cdot \text{H}_2\text{O}$, <i>manganese phosphite, manganous phosphite</i>. Reddish white, loose powder; sl. sol. in water; sol. in $\text{MnCl}_2 + \text{Aq}$ or $\text{MnSO}_4 + \text{Aq}$; loses its cryst. water at 200°.	$2\text{ZnHPO}_3 \cdot 5\text{H}_2\text{O}$, <i>zinc phosphite</i>. Granular, cryst. powder; sol. in cold water, less easily in hot; loses its cryst. water at 280°; decomp. at red heat.	Phosphite
Co_2SiO_4, <i>cobalt silicate, cobaltous orthosilicate</i>. Violet-colored, gelatinous ppt.; amorph. powder when dry; insol. in water; hot HCl separates gelatinous silicic acid. $x\text{CoO} \cdot y\text{K}_2\text{O} \cdot z\text{SiO}_3$, <i>cobalt potassium silicate, small, blue powder</i>. Insol. in water.	Ni_2SiO_4, <i>nickel silicate, nickelous orthosilicate, genthite</i>. Bluish gelatinous ppt.; amorph. powder when dry; insol. in water; easily decomp. by acids.	Mn_2SiO_4, <i>manganese silicate, manganous orthosilicate, braunite, rhodonite, tephroite</i>. Reddish gray, rhombic cryst. or yellow powder; insol. in water; decomp. by HCl, with separation of gelatinous silicic acid.	$\text{Zn}_2\text{SiO}_4 \cdot 3\text{H}_2\text{O}$, <i>zinc silicate, zinc orthosilicate, calamine, willemite</i>. White, amorph. powder or transparent, whitish, rhombic cryst., with pearly luster; insol. in water; sol. in HCl, H_2O_2 or $\text{KOH} + \text{Aq}$; decomp. by acids, with separation of	Silicate

Al, Cr, Fe, Co, Ni, Mn, Zn GROUP

	Aluminium	Chromium	Iron(ferrous)	Iron(ferric)
Silicate Cont.	Occurs extensively native as clay and rocks of varying compn.; kaolin is nearly pure; white masses or amorph. powder; insol. in water, dil. HCl or HNO ₃ ; sl. sol. in hot dil. H ₂ SO ₄ ; easily sol. in H ₂ SiF ₆ ; decomp. by boiling with KOH + Aq or Na ₂ CO ₃ + Aq.			
Silico-fluoride	Al ₂ (SiF ₆) ₃ , <i>aluminium silicofluoride, aluminium fluosilicate</i> . White powder; easily sol. in water; slowly sol. if the salt has been ignited.	Cr ₂ (SiF ₆) ₃ , <i>chromium silicofluoride, chromic silicofluoride, chromic fluosilicate</i> . Sol. in water.	FeSiF ₆ .6H ₂ O, <i>iron silicofluoride, ferrous silicofluoride, ferrous fluosilicate</i> . Blue-green cryst. or yellowish white, cryst. powder; easily sol. in water.	Fe ₂ (SiF ₆) ₃ , <i>iron silicofluoride, ferric silicofluoride, ferric fluosilicate</i> . Sol. in water.
Sulfate	Al ₂ (SO ₄) ₃ .18H ₂ O, <i>aluminium sulfate, normal aluminium sulfate, pickle alum, aluminium vitriol, alum, cake alum, concentrated alum, pearl alum, alunogenite, hair salt, feather alum</i> . Thin, white, six-sided plates, with pearly luster; in scales or granules, with soapy feeling; sometimes white or yellowish, cryst. lumps or powder, with sweet, astringent taste; all forms are sol. in water. 31 g. in 100 g. of water at 0°, 36 g. at 20°, 89 g. at 100°; insol. in alcohol or concd. H ₂ SO ₄ ; melts in its cryst. water when heated and decomp. at red heat to SO ₃ and Al ₂ O ₃ . Al ₂ (SO ₄) ₃ .9H ₂ O, <i>aluminium sulfate, alum cake, patent alum, dried alum</i> .	CrSO ₄ .7H ₂ O, <i>chromium sulfate, chromous sulfate</i> . Blue cryst. that absorb O ₂ rapidly from the air; strong reducing agent; sol. in water, 12 g. in 100 g. of water at 0°; sl. sol. in alcohol. Cr ₂ (SO ₄) ₃ .18H ₂ O, <i>chromium sulfate, chromic sulfate, normal chromic sulfate, violet chromic sulfate, wool mordant</i> . Regular octahedra; red-violet in reflected light, garnet-red in transmitted light; loses 12H ₂ O and turns green at 100°; insol. in alcohol; sol. in water, 120 g. in 100 g. of water, to a violet soln. which turns green when heated to 65° or 70°, or when treated with cold H ₂ SO ₄ or HNO ₃ . Cr ₂ (SO ₄) ₃ .6H ₂ O, <i>chromium sulfate, green chromic sul-</i>	FeSO ₄ .7H ₂ O, <i>iron sulfate, ferrous sulfate, normal ferrous sulfate, salt of colcothar, copperas, green vitriol, iron vitriol, salts of steel, melanterite, green copperas</i> . Large, bluish green, efflor., odorless, monoclinic or rhombic cryst.; often dirty and rusty from efflor. and oxidation to basic ferric sulfate; saline, astringent taste; sol. in water, 16 g. in 100 g. of water at 0°, 26 g. at 20°, 43 g. at 90°; insol. in alcohol; melts in its cryst. water when heated; loses 6H ₂ O at 100°, the last molecule at c. 300° and at sl. higher temp. decomp. to SO ₃ , O ₂ and Fe ₂ O ₃ ; the aq. soln. absorbs NO; sp. gr. 1.9. FeSO ₄ , <i>anhydrous ferrous sulfate, shoemakers black</i> .	Fe ₂ (SO ₄) ₃ , <i>iron sulfate, ferric sulfate, normal ferric sulfate, nitrosulfate</i> . Peach-blossom-colored, rhombic, tabular octahedra or a grayish white powder, that deliq. to a brown liquid; slowly sol. in water to yellowish brown soln.; rapidly sol. in water, containing a trace of FeSO ₄ ; insol. in concd. H ₂ SO ₄ .

Cobalt	Nickel	Manganese	Zinc	Silicate Cont.
			gelatinous silicic acid.	
CoSiF₆.6H₂O , <i>cobalt silicofluoride, cobaltous silicofluoride, cobaltous fluosilicate</i> . Easily sol. in water.	NiSiF₆.6H₂O , <i>nickel silicofluoride, nickelous silicofluoride, nickelous fluosilicate</i> . Green, rhombic cryst. or hexagonal prisms; easily sol. in water; decomp. at red heat to NiF ₂ and SiF ₄ .	MnSiF₆.6H₂O , <i>manganese silicofluoride, manganous silicofluoride, manganous fluosilicate</i> . Hexagonal cryst.; sol. in water; loses cryst. water when heated, and then decomp. to MnF ₂ and SiF ₄ .	ZnSiF₆.6H₂O , <i>zinc silicofluoride, zinc fluosilicate</i> . White hexagonal plates; very easily sol. in water.	Silico-fluoride
CoSO₄.7H₂O , <i>cobalt sulfate, cobaltous sulfate, normal cobaltous sulfate, cobalt vitriol, ordinary cobalt sulfate, bieberte</i> . Red, monoclinic, rhombic prisms; metallic, sl. bitter taste; stable in air; sol. in water, 25 g. of the anhydrous salt in 100 g. of water at 0°, 36 g. at 20°, 83 g. at 100°; insol. in alcohol; loses all its cryst. water when heated; sp. gr. 1.9.	NiSO₄.7H₂O , <i>nickel sulfate, nickelous sulfate, normal nickelous sulfate, nickel vitriol, ordinary nickel sulfate, blue salts, morensite</i> . Emerald green, rhombic prisms; sweet, astringent taste; sol. in water, 27 g. of the anhydrous salt in 100 g. of water at 0°, 37 g. at 22°, 43 g. at 98°; insol. in alcohol; M. P. 98° to 100°; loses 6H ₂ O at 103°; becomes anhydrous at 279° and turns greenish yellow at c. 300°; sp. gr. 1.9.	MnSO₄.7H₂O , <i>manganese sulfate, manganous sulfate, normal manganous sulfate</i> . Nearly transparent, very pale rose-colored, efflor., monoclinic prisms; bitterish, astringent taste; very sol. in water, 53 g. of the anhydrous salt in 100 g. of water at 0°, 64 g. at 25°, 30 g. at 100°; insol. in abs. alcohol; M. P. 19°.	ZnSO₄.7H₂O , <i>zinc sulfate, normal zinc sulfate, white vitriol, zinc vitriol, white copperas, goslarite, salt of vitriol</i> . Colorless or white, right rhombic cryst. or white, cryst. powder; astringent, metallic taste; slowly efflor. in dry air; acid reaction; sol. in water, 41 g. in 100 g. of water at 0°, 58 g. at 25°, 81 g. at 100°; insol. in alcohol or HC ₂ H ₃ O ₂ ; M. P. 50°; loses 6 H ₂ O at 100° and the last molecule at low red heat, above which the anhydrous salt decomp.; sp. gr. 1.9.	Sulfate
CoSO₄ , <i>anhydrous cobaltous sulfate</i> . Reddish, hexagonal prisms or powder; not easily decomp. by heat; sp. gr. 3.7.	NiSO₄.6H₂O , <i>nickelous sulfate</i> . Bluish, tetragonal pyramids or greenish, monoclinic cryst.; sol. in water; sp. gr. 2.	MnSO₄.4H₂O , <i>manganous sulfate</i> . Large cryst.; closely resembles MnSO ₄ .7H ₂ O; commercial manganese sulfate is probably a mixture of the two; sp. gr. 2.1.	ZnSO₄ , <i>anhydrous zinc sulfate</i> . Fine, white, powder; sol. in water, with evolution of heat; decomp at 740° to ZnO, O ₂ and SO ₂ ; sp. gr. 3.7.	
Co₂(SO₄)₃.18H₂O , <i>cobalt sulfate, cobaltic sulfate, normal cobaltic sulfate</i> . Blue, cryst. powder or small, thin needles with silky luster; fairly stable in moist air;	NiSO₄ , <i>anhydrous nickelous sulfate</i> . Clear, yellow powder or citron-yellow, regular octahedra; absorbs	MnSO₄ , <i>anhydrous manganous sulfate</i> . White or faintly reddish yellow powder; bitter, metallic taste; sol. in water; absorbs water from the air and forms		

Al, Cr, Fe, Co, Ni, Mn, Zn GROUP

Sulfate
Cont.

Aluminium	Chromium	Iron(ferrous)	Iron(ferric)
White; sol. in water. $\text{Al}_2(\text{SO}_4)_3$, <i>anhydrous aluminium sulfate</i> . White, amorph. powder or porous lumps; slowly sol. in water.	<i>fate</i> . Green, amorph. masses; easily sol. in alcohol or concd. H_2SO_4 ; sol. in water to a green soln., which turns violet after standing 3 to 4 weeks. $\text{Cr}_2(\text{SO}_4)_3$, <i>anhydrous chromic sulfate</i> . Insol. in water, NH_4OH , H_2SO_4 , HNO_3 , HCl or aqua regia; decomp. by boiling caustic alkalies; sp. gr. 3.	Grayish white powder; sol. in water to a green soln.	
$x\text{Al}_2\text{O}_3.y\text{SO}_3.z\text{H}_2\text{O}$, <i>basic aluminium sulfate</i> . White, amorph. powder of varying compn.; insol. in water; easily sol. in HCl or cold dil. mineral acids. Unknown.	$x\text{Cr}_2\text{O}_3.y\text{SO}_3.z\text{H}_2\text{O}$, <i>basic chromic sulfate, koreon</i> . Insol. in water; sol. in acids; slowly decomp. by $\text{KOH} + \text{Aq}$.	Unknown.	$x\text{Fe}_2\text{O}_3.y\text{SO}_3.z\text{H}_2\text{O}$, <i>basic ferric sulfate, Monsel's salt</i> . Yellowish brown powder; insol. in water.
	$2\text{Cr}_2(\text{SO}_4)_3.\text{H}_2\text{SO}_4$, <i>acid chromic sulfate</i> . Reddish powder; insol. in water or acids.	$\text{FeSO}_4.\text{H}_2\text{SO}_4.6\text{H}_2\text{O}$, <i>acid ferrous sulfate</i> . Colorless tablets.	Unknown.
$\text{Al.Na}_2(\text{SO}_4)_4.24\text{H}_2\text{O}$, <i>aluminium sodium sulfate, soda alum, porous alum, mendozite</i> . Transparent, colorless octahedra; efflor. in dry air and loses all its cryst. water at 40° to 50° ; sol. in water, 51 g. in 100 g. of water at 16° ;	$\text{Cr.Na}_2(\text{SO}_4)_4.24\text{H}_2\text{O}$, <i>chromium sodium sulfate, chromic sodium sulfate, soda chrome alum</i> . Indefinite cryst.; more efflor. than the K or NH_4 salt; sol. in water; loses $18\text{H}_2\text{O}$ at 100° . $\text{Cr}_2\text{K}_2(\text{SO}_4)_4.24\text{H}_2\text{O}$, <i>chromium</i>	$\text{FeNa}_2(\text{SO}_4)_2.4\text{H}_2\text{O}$, <i>iron sodium sulfate, ferrous sodium sulfate</i> . Blue-green, monoclinic tablets; sol. in water. $\text{FeK}_2(\text{SO}_4)_2.6\text{H}_2\text{O}$, <i>iron potassium sulfate, ferrous potassium sulfate</i> . Blue-green, monoclinic cryst.; sol. in wa-	$\text{FeK}_2(\text{SO}_4)_4.24\text{H}_2\text{O}$, <i>iron potassium sulfate, ferric potassium sulfate, potash iron alum, iron alum</i> . Colorless or pale violet, octahedral cryst.; sol. in water; decomp. slowly in air to a yellowish white powder; melts in its cryst.

Cobalt	Nickel	Manganese	Zinc
in dry air it decomp. rapidly, losing water and turning to a brown, then red powder; easily sol. in water, with decomp. and evolution of O_2 ; sol. in concd. HNO_3 , $HC_2H_3O_2$, and dil. or concd. H_2SO_4 ; sol. in HCl , with evolution of Cl_2 .	water from the air and becomes green; decomp. when heated; sp. gr. 3.6.	$MnSO_4 \cdot 4H_2O$; stable at low heat; decomp. at full red heat to SO_2 , O_2 and Mn_2O_3 ; M. P. 700° ; sp. gr. 3.2. $Mn_2(SO_4)_3$, <i>manganese sulfate</i> , <i>manganic sulfate</i> , <i>normal manganic sulfate</i> . Dark green, amorph. powder; deliq. very easily to a violet liquid; sol. in water, with evolution of heat and decomp. into a basic sulfate; decomp. by dil. acids or abs. alcohol; sol. in concd. HCl ; insol. in concd. HNO_3 or H_2SO_4 ; stable even at 160° ; decomp. above 160° .	
$xCoO \cdot ySO_3 \cdot zH_2O$, <i>basic cobaltous sulfate</i> . Bluish powder, sometimes gelatinous, sometimes cryst.; insol. in water.	$xNiO \cdot ySO_3 \cdot zH_2O$, <i>basic nickelous sulfate</i> . Green or yellowish green, amorph. powder; or microscopic needles; very sl. sol. in water.	$3MnO \cdot 2SO_3$, $3H_2O$, <i>basic manganous sulfate</i> . Rose-red cryst. powder; insol. in water, but slowly decomp. thereby.	$xZnO \cdot ySO_3 \cdot zH_2O$, <i>basic zinc sulfate</i> . Loose, white, amorph. powder; absorbs CO_2 from the air; insol. in water.
Unknown.	Unknown.	$Mn(HSO_4)_2 \cdot H_2O$, <i>acid manganous sulfate</i> . Thin tablets with pearly luster; sol. in water with decomp. $Mn_2H \cdot (SO_4)_4 \cdot 8H_2O$, <i>acid manganic sulfate</i> . Reddish brown, deliq. cryst.; decomp. by water; sol. in dil. H_2SO_4 ; decomp. by heat to $Mn_2(SO_4)_3$, H_2SO_4 and H_2O .	$ZnH(SO_4) \cdot 8H_2O$, <i>acid zinc sulfate</i> . Monoclinic cryst.; sol. with difficulty in cold, easily in hot water; decomp. when melted into ZnO , SO_2 and H_2O .
$CoK_2(SO_4)_2 \cdot 6H_2O$, <i>cobalt potassium sulfate, cobaltous potassium sulfate</i> . Red, monoclinic, tubular cryst.; sol. in water, but less so than $CoSO_4$. $Co(NH_4)_2(SO_4)_2 \cdot 6H_2O$, <i>cobalt ammonium sulfate, cobaltous ammonium sulfate</i> . Red,	$NiK_2(SO_4)_2 \cdot 6H_2O$, <i>nickel potassium sulfate, nickelous potassium sulfate</i> . Bluish green, monoclinic, prismatic cryst.; sol. in water; turns yellow when dried; melts to a brown liquid, which solidifies to a yellow, cryst. mass.	$MnNa_2(SO_4)_2 \cdot 2H_2O$, <i>manganese sodium sulfate, manganous sodium sulfate</i> . Pale yellow, oblique, triclinic, rhombic prisms; deliq. in moist air; sol. in water. $MnK_2(SO_4)_2 \cdot 4H_2O$, <i>manganese potassium sulfate</i> ,	$ZnNa_2(SO_4)_2 \cdot 4H_2O$, <i>zinc sodium sulfate</i> . Monoclinic cryst.; deliq. in moist air; sol. in water; melts at red heat and loses its cryst. water. $ZnK_2(SO_4)_2 \cdot 6H_2O$, <i>zinc potassium sulfate</i> . Monoclinic cryst.; sol. in water.

Sulfate
Cont.

Al, Cr, Fe, Co, Ni, Mn, Zn GROUP

Sulfate

Cont.

Aluminium	Chromium	Iron(ferrous)	Iron(ferric)
insol. in abs. alcohol. $\text{Al}_2\text{K}_2(\text{SO}_4)_4$. $24\text{H}_2\text{O}$, aluminium potassium sulfate, potash alum, alum, ordinary alum, cube alum, kalin-ite, alum meal, alum flour, alum stone, alumen, alumenite, Roman alum. Transparent, colorless, regular octahedra, or large, glassy, irregular lumps, or whitish cryst. powder; occasionally cube-like cryst.; sl. sweetish, astringent taste; acid reaction; very sl. efflor.; sol. in water, with absorption of heat, 5.6 g. in 100 g. of water at 0°, 11 g. at 20°, 2275 g. at 90°; insol. in alcohol; melts at 92° in its cryst. water; loses $23\text{H}_2\text{O}$ at 190° and then decomp. $\text{K}_2\text{Al}_2(\text{SO}_4)_4$, anhydrous aluminium potassium sulfate, burnt alum, dried alum. White; sol. in water. $x\text{K}_2\text{O} \cdot y\text{Al}_2\text{O}_3 \cdot z\text{SO}_3$. $u\text{H}_2\text{O}$, basic aluminium potassium sulfate, alunite. White. $\text{Al}_2(\text{NH}_4)_2(\text{SO}_4)_4$. $24\text{H}_2\text{O}$, aluminium ammonium sulfate, ammonia alum, tschermigite. Transparent, colorless octahedra; acid reaction; sol. in water, 3.9 g. in 100 g. of water at 0°, 15 g. at 20°, 66 g. at 60°; insol. in alcohol; loses $23\text{H}_2\text{O}$ at 190° and some NH_3 at 193°.	potassium sulfate, chromic potassium sulfate, potash chrome alum, chrome alum. Large, violet to dark purple, efflor. octahedra; sol. in water, 25 g. in 100 g. of water at 25°; insol. in alcohol; aq. soln. is violet; becomes green, pasty and non-crystallizable when heated to 70° or 80°, but turns back to violet after standing several weeks; loses $22\text{H}_2\text{O}$ at 200°, $24\text{H}_2\text{O}$ at 400°. $\text{Cr}_2(\text{NH}_4)_2(\text{SO}_4)_4$. $24\text{H}_2\text{O}$, chromium ammonium sulfate, chromic ammonium sulfate, ammonia chrome alum. Ruby-red octahedra; slowly efflor. in air; sol. in water, 21 g. in 100 g. of water at 25°; insol. in alcohol; acts like the K salt when in soln.; loses $18\text{H}_2\text{O}$ at c. 100°.	ter, 20 g. of the anhydrous salt in 100 g. of water at 0°, 36 g. at 25°, 64 g. at 70°. $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2$. $6\text{H}_2\text{O}$, iron ammonium sulfate, ferrous ammonium sulfate, Mohr's salt. Clear, bluish-green, monoclinic cryst.; sol. in water, 12 g. of the anhydrous salt in 100 g. of water at 0°, 25 g. at 25°, 52 g. at 70°.	water; at 80° it breaks down into H_2SO_4, $\text{Fe}_2(\text{SO}_4)_3$, and a basic ferric potassium sulfate. $\text{Fe}_2(\text{NH}_4)_2(\text{SO}_4)_4$. $24\text{H}_2\text{O}$, iron ammonium sulfate, ferric ammonium sulfate, ammonia iron alum, iron alum. Colorless octahedra or white powder; sol. in water, 124 g. in 100 g. of water at 25°; loses $23\text{H}_2\text{O}$ at 150°, the last molecule at 230°.
Sulfide	Al_2S_3, aluminium sulfide, aluminium trisulfide. Yellow cryst. with bitter taste; sometimes	CrS, chromium sulfide, chromous sulfide, chromium monosulfide. Black powder; in-	FeS, iron sulfide, ferrous sulfide, iron monosulfide, iron sulfuret, troilite. Yellow-brown,

Cobalt	Nickel	Manganese	Zinc	Sulfate Cont.
monoclinic, tabular cryst.; sol. in water, 6 g. in 100 g. of water at 0°, 13 g. at 20°, 49 g. at 80°; insol. in alcohol. $\text{Co}_2\text{K}_2(\text{SO}_4)_4$. $24\text{H}_2\text{O}$, cobalt potassium sulfate, cobaltic potassium sulfate, cobalt potassium alum. Regular octahedra; sol. in water with decomp. $\text{Co}_2(\text{NH}_4)_2(\text{SO}_4)_4$. $24\text{H}_2\text{O}$, cobalt ammonium sulfate, cobaltic ammonium sulfate, cobalt ammonia alum. Deep blue, regular octahedra; sol. in water, with decomp.	$\text{Ni}(\text{NH}_4)_2(\text{SO}_4)_2$. $6\text{H}_2\text{O}$, nickel ammonium sulfate, nickelous ammonium sulfate. Bluish green, monoclinic cryst.; generally prismatic; occasionally tabular; sol. in water, 1 g. in 100 g. of water at 0°, 6.5 g. at 20°, 20 g. at 70°; nearly insol. in dil. $(\text{NH}_4)_2\text{SO}_4 + \text{Aq}$.	manganous potassium sulfate. Pale red, monoclinic, right-angled tablets; sol. in water. $\text{Mn}(\text{NH}_4)_2(\text{SO}_4)_2$. $6\text{H}_2\text{O}$, manganese ammonium sulfate, manganous ammonium sulfate. Pale rose-red, deliq. monoclinic, cryst.; easily sol. in water, 37 g. of the anhydrous salt in 100 g. of water at 25°. $\text{Mn}_2\text{K}_2(\text{SO}_4)_4$. $24\text{H}_2\text{O}$, manganese potassium sulfate, manganic potassium sulfate, manganese potassium alum. Dark violet octahedra; decomp. by water. $\text{Mn}_2(\text{NH}_4)_2(\text{SO}_4)_4$. $24\text{H}_2\text{O}$, manganese ammonium sulfate, manganic ammonium sulfate, manganese ammonia alum. Dark red cryst.; decomp. by water.	$\text{Zn}(\text{NH}_4)_2(\text{SO}_4)_2$. $6\text{H}_2\text{O}$, zinc ammonium sulfate. Clear, monoclinic cryst.; sol. in water, 7 g. of the anhydrous salt in 100 g. of water at 0°, 12.5 g. at 20°, 42 g. at 80°. $\text{Al}_2\text{Zn}(\text{SO}_4)_4$. $24\text{H}_2\text{O}$, aluminium zinc sulfate, zinc aluminium sulfate, zinc alum. White; sol. in water.	Sulfide
CoS, cobalt sulfide, cobaltous sulfide, cobalt monosulfide, syepoorite. Black, amorph.	NiS, nickel sulfide, nickelous sulfide, nickel monosulfide, millerite, hair pyrites, capillary py-	MnS, manganese sulfide, manganous sulfide, manganese monosulfide, alabandite, manga-	ZnS, zinc sulfide, zinc monosulfide, zinc blend, black jack, blend, jack, resin jack, sphaler-	

Al, Cr, Fe, Co, Ni, Mn, Zn GROUP

	Aluminium	Chromium	Iron(ferrous)	Iron(ferric)
Sulfide Cont.	black, amorph. masses; decomp. by water, with evolution of H_2S and formation of hydrated Al_2O_3 ; decomp. similarly in moist air; melts with difficulty; burns in air to Al_2O_3 and SO_2 ; M. P. 1100° ; sp. gr. 2.	sol. in water or $\text{K}_2\text{S} + \text{Aq}$; sol. in acids; decomp. when heated in air; sp. gr. 4.1. Cr_2S_3 , chromium sulfide, chromic sulfide, chromium trisulfide. Grayish green to black, cryst. tablets or brown amorph. powder; insol. in H_2O or alkaline sulfide solns.; not attacked by acids, except HNO_3 and aqua regia, which dissolve it; heated in air it gives SO_2 and Cr_2O_3 ; sp. gr. 3.7. Cr_2S_4 , chromous chromic sulfide, chromium tetrasulfide. Grayish black powder; insol. in water, HCl or dil. H_2SO_4 ; easily sol. in concd. HNO_3 .	lustrous, metal-like solid, hexagonal prisms, or amorph. greenish black powder; non-magnetic; freshly pptd. FeS oxidizes easily to FeSO_4 on exposure to air or by gentle heating; insol. in water; dil. HCl or H_2SO_4 evolves H_2S and forms FeCl_2 or FeSO_4 ; oxidized by HNO_3 ; M. P. 1193° ; sp. gr. 4.8.	netic; insol. in water; decomp. by dil. HCl or H_2SO_4 to H_2S , insol. FeS_2 and sol. FeCl_3 or FeSO_4 ; sp. gr. 4.3. $\text{xFeS.yFe}_2\text{S}_3$, ferrous-ferric sulfide, magnetic sulfide of iron, magnetic pyrites. Hexagonal cryst. or amorph. powder; color varies from gray to brown; magnetic; decomp. by acids. FeS_2 , iron disulfide, iron pyrites, pyrites, fool's gold, white pyrite, white iron pyrite, pyrite, marcasite, coal brasses, cockscomb pyrites, spear pyrites, radiated pyrites. Bulky, dark yellow powder or brassy yellow, lustrous cubes or octahedra; non-magnetic; insol. in water, dil. HCl or H_2SO_4 ; sol. in concd. HCl ; decomp. by HNO_3 or aqua regia, with separation of S ; sp. gr. 4.8.
Sulfite	$\text{Al}_2(\text{SO}_3)_3$, aluminium sulfite, normal aluminium sulfite. Gummy masses that oxidize to a basic salt when exposed to air; insol. in water. $\text{Al}_2\text{O}_3.\text{SO}_2.4\text{H}_2\text{O}$, basic aluminium sulfite. White powder; insol. in water; sol. in H_2SO_4 ; loses H_2O and SO_2 when heated.	CrSO_3 , chromium sulfite, chromous sulfite. Reddish powder; insol. in water. $\text{Cr}_2(\text{SO}_3)_3$, chromium sulfite, chromic sulfite, normal chromic sulfite. Greenish white, amorph. powder; insol. in water; sol. in acids; found mostly in soln. $2\text{Cr}_2\text{O}_3.3\text{SO}_2.16\text{H}_2\text{O}$, basic chromic sulfite. Pale green, amorph. powder; insol. in water.	$2\text{FeSO}_3.5\text{H}_2\text{O}$, iron sulfite, ferrous sulfite, normal ferrous sulfite. Very sl. sol. in water; easily sol. in H_2SO_4 ; insol. in alcohol; loses H_2O and SO_2 at 250° ; the moist salt oxidizes easily in air.	$\text{Fe}_2(\text{SO}_3)_3$, iron sulfite, ferric sulfite, normal ferric sulfite. Known only in soln. $\text{xFe}_2\text{O}_3.\text{ySO}_2.\text{zH}_2\text{O}$, basic ferric sulfite. Yellowish powder; insol. in water; sol. in acids.
Tartrate	$\text{Al}_2(\text{C}_4\text{H}_4\text{O}_6)_3$, aluminium tartrate. White powder; sol. in water.	$\text{Cr}_2(\text{C}_4\text{H}_4\text{O}_6)_3$, chromium tartrate, chromic tartrate. Violet flakes; sol. in water.	$\text{FeC}_4\text{H}_4\text{O}_6$, iron tartrate, ferrous tartrate. Greenish, microscopic, cryst. powder; very sl. sol. in water.	$\text{Fe}_2(\text{C}_4\text{H}_4\text{O}_6)_3$, iron tartrate, ferric tartrate. Brown scales; sol. in water.

Cobalt	Nickel	Manganese	Zinc	Sulfide Cont
powder or bronze-colored, lustrous needles; non-magnetic; insol. in water; sol. in concd. acids; and in dil. acids except HCl. Co_2S_3, <i>cobalt sulfide</i>, <i>cobaltic sulfide</i>, <i>cobalt pyrites</i>, <i>linnaeite</i>. Black, amorph. powder or graphite-like cryst.; decomp. partially by HCl, entirely by HNO_3. The <i>polysulfides</i>, CoS_2, Co_2S_4 and Co_3S_8, are definitely known; black or gray powders; decomp. by acids.	<i>rites</i>, <i>nickel pyrites</i>, <i>nickel blend</i>. Dark gray or black, amorph. powder, brownish black ppt., or yellow, brittle, cryst. solid; insol. in water or dil. acids; sol. in concd. acids; when freshly pptd. it is insol. in $\text{H}_2\text{C}_2\text{O}_4$, but oxidizes slowly to NiSO_4; markedly sol. in NH_4OH with brown color; M. P. 797°; sp. gr. 4.6. The <i>polysulfides</i>, Ni_2S, NiS_2 and Ni_3S_4, are definitely known; gray or yellow powders; slowly decomp. by acids.	<i>nese blend</i>. Yellowish green, hexagonal prisms when native; ordinarily a rose or flesh-colored ppt.; occasionally a greenish ppt., a solid, or small, eight-sided plates; flesh-colored MnS oxidizes easily in air to MnSO_4; insol. in water; sol. in dil. acids even $\text{H}_2\text{C}_2\text{O}_4$; heated in air SO_2 and Mn_2O_4 are formed; sp. gr. 3.9. MnS_2, <i>manganese sulfide</i>, <i>manganic sulfide</i>, <i>manganese disulfide</i>, <i>hauerite</i>. Large, brown-black, lustrous, regular octahedra or red, amorph. powder; stable in air; insol. in water; decomp. by acids; sp. gr. 3.5. The <i>polysulfide</i>, Mn_3S_4, is said to exist.	<i>ite</i>, <i>wurtzite</i>, <i>false lead</i>, <i>pseudogalenite</i>. Gray to black, cryst. solid when native; white or yellowish white, amorph. ppt.; the former is slowly attacked by acids; pptd. ZnS is insol. in water, NH_4OH or alkaline hydroxide soln.; easily sol. in dil. HCl, HNO_3 or H_2SO_4; insol. in $\text{HC}_2\text{H}_3\text{O}_2$; M. P. 1850° at 150 atmospheres; sp. gr. 4. The <i>polysulfide</i>, ZnS_2, is said to exist.	
$\text{CoSO}_3 \cdot 5\text{H}_2\text{O}$, <i>cobalt sulfite</i>, <i>cobaltous sulfite</i>, <i>normal cobaltous sulfite</i>. Red, granular powder; insol. in water; sol. in H_2SO_4. $\text{xCoO} \cdot \text{ySO}_2 \cdot \text{zH}_2\text{O}$, <i>basic cobaltous sulfite</i>. Powder; decomp. by water.	$\text{NiSO}_3 \cdot 6\text{H}_2\text{O}$, <i>nickel sulfite</i>, <i>nickelous sulfite</i>, <i>normal nickelous sulfite</i>. Cryst. crusts or green tetrahedral cryst.; insol. in water; sol. in H_2SO_4.	$\text{MnSO}_3 \cdot 5\text{H}_2\text{O}$, <i>manganese sulfite</i>, <i>manganous sulfite</i>, <i>normal manganous sulfite</i>. Reddish white, cryst. powder; sl. sol. in water; easily sol. in H_2SO_4; decomp. by mineral acids; insol. in alcohol.	$\text{ZnSO}_3 \cdot 5\text{H}_2\text{O}$, <i>zinc sulfite</i>, <i>normal zinc sulfite</i>. Small, lustrous, monoclinic prisms that absorb O_2 from the air readily; pungent taste; very sl. sol. in water; easily sol. in H_2SO_4; sol. in HN_4OH; insol. in alcohol; decomp. by boiling water to a basic salt, $\text{xZnSO}_3 \cdot \text{yZnO} \cdot \text{zH}_2\text{O}$; decomp. at 200° to SO_2, S and ZnO.	Sulfite
$\text{CoC}_4\text{H}_4\text{O}_6$, <i>cobalt tartrate</i>, <i>cobaltous tartrate</i>. Pink powder; sol. in water.	$\text{NiC}_4\text{H}_4\text{O}_6 \cdot 5\text{H}_2\text{O}$, <i>nickel tartrate</i>, <i>nickelous tartrate</i>. Light green powder; insol. in water; sol. in acids.	$\text{MnC}_4\text{H}_4\text{O}_6$, <i>manganese tartrate</i>, <i>manganous tartrate</i>. White powder; sparingly sol. in water.	$\text{ZnC}_4\text{H}_4\text{O}_6 \cdot 2\text{H}_2\text{O}$, <i>zinc tartrate</i>. White powder; insol. in water; sol. in acids.	Tartrate

Al, Cr, Fe, Co, Ni, Mn, Zn GROUP

	Aluminium	Chromium	Iron(ferrous)	Iron(ferric)
Thio- cyanate	$\text{Al}(\text{SCN})_3$, aluminium thiocyanate, aluminium sulfocyanide, aluminium sulfocyanate. White, deliq., cryst. solid; sol. in water; usually found only in soln., which decomp. when heated.	$\text{Cr}(\text{SCN})_3$, chromium thiocyanate, chromic thiocyanate, chromium sulfocyanide, chromic sulfocyanide, chromium sulfocyanate. Dark green or gray, deliq., amorph. powder; sol. in water to a greenish violet soln., the green color being intensified by heating; reduced to Cr_2O_3 by heat.	$\text{Fe}(\text{SCN})_2$, iron thiocyanate, ferrous thiocyanate, iron sulfocyanide, ferrous sulfocyanide, ferrous sulfocyanate. Large, greenish; oblique, rhombic prisms; turns red in the air; easily sol. in water or alcohol; decomp. by heat.	$\text{Fe}(\text{SCN})_3 \cdot 3\text{H}_2\text{O}$, iron thiocyanate, ferric thiocyanate, iron sulfocyanide, ferric sulfocyanide, ferric sulfocyanate. Small, brown to dark brown or blackish red, deliq., cubic cryst.; easily sol. in water to an intensely blood-red soln.; easily sol. in alcohol.
Thio- sulfate	Unknown.	Unknown.	$\text{FeS}_2\text{O}_5 \cdot 5\text{H}_2\text{O}$, iron thiosulfate, ferrous thiosulfate, ferrous hyposulfite. Greenish blue, very hygroscopic cryst. or cryst. masses; oxidizes easily in air; very sol. in water or alcohol.	Unknown.
Tungstate	$\text{Al}_2(\text{WO}_4)_3 \cdot 8\text{H}_2\text{O}$, aluminium tungstate, aluminium orthotungstate, aluminium wolframate. Cheese-like ppt.; insol. in water; easily sol. in H_3PO_4 , $\text{H}_2\text{C}_2\text{O}_4$ or $\text{H}_2\text{C}_4\text{H}_4\text{O}_6 + \text{Aq.}$	$\text{Cr}_2(\text{WO}_4)_3 \cdot 20\text{H}_2\text{O}$, chromium tungstate, chromic tungstate, chromic orthotungstate, chromic wolframate. Bright green, amorph. powder; insol. in water; sol. in $\text{CrCl}_3 + \text{Aq.}$, H_3PO_4 , $\text{H}_2\text{C}_2\text{O}_4$ or $\text{H}_2\text{C}_4\text{H}_4\text{O}_6 + \text{Aq.}$; loses $13\text{H}_2\text{O}$ at 100° .	$\text{FeWO}_4 \cdot 3\text{H}_2\text{O}$, iron tungstate, ferrous tungstate, ferrous orthotungstate, ferrous wolframate. Bright brown, amorph. powder; insol. in water; sol. in cold H_2SO_4 , HCl or HNO_3 ; decomp. by boiling acids, with separation of canary-yellow WO_3 ; sol. in boiling H_3PO_4 or warm $\text{H}_2\text{C}_2\text{O}_4 + \text{Aq.}$ FeWO_4 , anhydrous ferrous tungstate. Opaque cryst.	$\text{Fe}_2\text{O}_3 \cdot 4\text{WO}_3 \cdot 4\text{H}_2\text{O}$, iron tungstate, ferric tungstate, ferric orthotungstate, ferric wolframate. Sol. in water, without decomp.

Cobalt	Nickel	Manganese	Zinc	
$2\text{Co}(\text{SCN})_2 \cdot \text{H}_2\text{O}$, cobalt thiocyanate, cobaltous thiocyanate, cobalt sulfocyanide, cobaltous sulfocyanide, cobaltous sulfocyanate. Deep blue, deliq. cryst.; sol. in water to a rose-red soln. when dil., but deep blue when concd.; sol. in alcohol.	$2\text{Ni}(\text{SCN})_2 \cdot \text{H}_2\text{O}$, nickel thiocyanate, nickelous thiocyanate, nickel sulfocyanide, nickelous sulfocyanide, nickelous sulfocyanate. Yellowish, cryst. powder; sol. in water or alcohol; loses its cryst. water at 150°.	$\text{Mn}(\text{SCN})_2 \cdot 3\text{H}_2\text{O}$, manganese thiocyanate, manganous thiocyanate, manganese sulfocyanide, manganous sulfocyanate. Cryst.; easily sol. in water or alcohol; loses its cryst. water at 160° to 170°.	$\text{Zn}(\text{SCN})_2$, zinc thiocyanate, zinc sulfocyanide, zinc sulfocyanate. White powder or cryst.; sol. in water or alcohol.	Thiocyanate
$\text{CoS}_2 \cdot \text{O}_3 \cdot 6\text{H}_2\text{O}$, cobalt thiosulfate, cobaltous thiosulfate, cobaltous hyposulfite. Bluish masses; sol. in water; decomp. by heat.	$\text{NiS}_2 \cdot \text{O}_3 \cdot 6\text{H}_2\text{O}$, nickel thiosulfate, nickelous thiosulfate, nickelous hyposulfite. Green or yellowish green cryst.; permanent in air; sol. in water; decomp. by heat.	$\text{MnS}_2 \cdot \text{O}_3$, manganese thiosulfate, manganous thiosulfate, manganous hyposulfite. Not very well known; sol. in water.	$\text{ZnS}_2 \cdot \text{O}_3 \cdot x\text{H}_2\text{O}$, zinc thiosulfate, zinc hyposulfite. Deliq., unstable masses; very easily sol. in water or alcohol.	Thio-sulfate
$\text{CoWO}_4 \cdot 2\text{H}_2\text{O}$, cobalt tungstate, cobaltous tungstate, cobaltous orthotungstate, cobaltous wolframate. Violet powder; insol. in water or cold HNO_3; sl. sol. in $\text{H}_2\text{C}_2\text{O}_4 + \text{Aq}$; entirely sol. in warm H_3PO_4, $\text{HC}_2\text{H}_3\text{O}_2$ or NH_4OH.	$\text{NiWO}_4 \cdot 6\text{H}_2\text{O}$, nickel tungstate, nickelous tungstate, nickelous orthotungstate, nickelous wolframate. Clear green, amorph. powder; insol. in water or $\text{H}_2\text{C}_2\text{O}_4 + \text{Aq}$; sol. in hot H_3PO_4, $\text{HC}_2\text{H}_3\text{O}_2$ or warm NH_4OH. NiWO_4, anhydrous nickelous tungstate. Brown, lustrous cryst.	$\text{MnWO}_4 \cdot 2\text{H}_2\text{O}$, manganese tungstate, manganous tungstate, manganous orthotungstate, manganous wolframate. Brown needles; insol. in water or cold HCl; sl. sol. in $\text{HC}_2\text{H}_3\text{O}_2$; sol. in warm H_3PO_4 or $\text{H}_2\text{C}_2\text{O}_4 + \text{Aq}$. MnWO_4, anhydrous manganous tungstate. Garnet-brown, lustrous, rhombic cryst.	ZnWO_4, zinc tungstate, zinc orthotungstate, zinc wolframate. Colorless prisms or tablets; insol. in water.	Tungstate

GROUP V

Silver	Ag
Lead	Pb
Mercury	Hg
Copper	Cu
Cadmium	Cd
Bismuth	Bi

The members of this group are generally hard, heavy, lustrous metals, all solid except Hg, which is liquid. Cu is reddish yellow; Bi is gray with a reddish tinge; the rest are gray. They are generally stable in air and unaffected by water; they generally dissolve in acids, tho not so readily as the metals of Group IV. Ag has a valence of 1; Bi has 3 or 5; the rest have a valence of 2 for the most part. No general formulas can be given for the oxides, because many members form several oxides. The *ous* and *ic* states are prominent in Hg and Cu; in the other members but one state is commonly present. The salts of this group are generally insoluble in water, tho the nitrates, chlorates, and acetates are soluble in water; also, some of the sulfates and some of the halogen salts are soluble in water.

The tendency to form colored salts is less prominent than in Groups III and IV. Cu salts are usually green or blue when crystallized, but white or yellow when anhydrous. The salts of the other metals are usually colorless or white, tho there is a fair sprinkling of colored ones. A few of these metals discolor the borax bead. Copper and sometimes lead give flame colorations.

Ag, Pb, Hg, Cu, Cd, Bi GROUP

Metal

	Silver	Lead	Mercury
	Ag, silver. White or light gray, very lustrous, malleable, ductile, exceedingly tenacious metal, harder than Au but softer than Cu; powdered Ag is a dark gray, or nearly black, non-lustrous powder that becomes white and lustrous when pressed or rubbed with a piece of iron; occasionally found as small cubical or octahedral cryst.; occurs in ingots, sheets, foil, wire and powder; reflects light and heat strongly; best conductor of heat and electricity; not acted on by water; does not oxidize in air, but is tarnished by the formation of a coating of Ag_2S; insol. in HCl or $\text{HCl}_2\text{H}_2\text{O}_2$; dil. HNO_3 dissolves it easily, giving off N oxides, probably N_2O and NO; concd. HNO_3 dissolves it with difficulty or not at all; sl. sol. in dil. H_2SO_4; sol. in hot, concd. H_2SO_4, with evolution of SO_2, but if a little $\text{Fe}_2(\text{SO}_4)_3$ is added, the Ag goes into soln. without heating; readily sol. in $\text{KCN} + \text{Aq}$; pure molten Ag absorbs c. 20 times its volume of O_2 from the air, but as it cools it "spits," and gives off the O_2; pptd. as amorph. lumpy powder from Ag solns. by metallic Fe, Zn or Cu; unites with the halogens and S easily. At. No. 47; At. Wt. 107.880; Mol. Wt. unknown; val. 1; sp. gr. 10.5; M. P. 960°; does not volatilize under ordinary conditions, but may be distilled as a blue vapor in the oxyhydrogen blowpipe flame in a block of burnt marble; B. P. 1950°; 2 isotopes.	Pb, lead, plum-bum, plomb, lead dust. Bluish gray, very malleable, somewhat ductile, sl. sonorous, not very tenacious metal; so soft it can easily be cut with a knife; has high luster on freshly cut surface, but oxidizes easily in air, forming a film of Pb_2O; occasionally found as regular octahedral cryst.; physical properties are much affected by small amounts of PbO or of metallic impurities; easily changed to PbO by heating in air or O_2; nearly insol. in cold, concd. HCl; attacked only sl. by hot, concd. HCl, in contact with air, not at all by cold, dil. HCl; easily sol. in HNO_3, more easily in dil. than in concd.; sol. in aqua regia, but insol. in a mixture of HNO_3 and H_2SO_4; insol. in dil. H_2SO_4; very slowly attacked by concd. H_2SO_4 at ordinary temp., but suddenly and rapidly at high temp., with evolution of SO_2 and H_2 and formation of PbSO_4 which usually separates as a white ppt., but sometimes dissolves in the excess of hot H_2SO_4; sol. in $\text{HCl}_2\text{H}_2\text{O}_2$, if in contact with air; combines with the halogens and S; forms alloys easily with other metals; pptd. in powdered form from Pb solns. by metallic Fe, Sn or Zn. At. No. 82; At. Wt. 207.20; Mol. Wt. not known with certainty, but probably same as the At. Wt.; val. usually 2, sometimes 4; sp. gr. 11.34; M. P. 327.5°; B. P. c. 1620°.	Hg, mercury, quicksilver. Heavy, silver-gray or nearly white, highly lustrous, very cohesive and mobile liquid metal; below -39° it forms a tin-white, ductile mass of octahedral or needle cryst. that may be cut with a knife; has high surface tension, and always takes on a spherical form when in small quantities or finely divided; does not adhere to glass when pure; stable in air at ordinary temp., but oxidizes slowly to red HgO when heated near the B. P. for some time; not attacked by water; insol. in hot, concd. HCl or dil. H_2SO_4; hot, concd. H_2SO_4 evolves SO_2 and forms Hg_2SO_4 or HgSO_4, according as Hg or H_2SO_4 is in excess; easily sol. in HNO_3; cold, dil. HNO_3, with excess of Hg forms mercurous nitrate, HgNO_2; Hg with excess of hot HNO_3 forms mercuric nitrate, $\text{Hg}(\text{NO}_3)_2$, with a tendency towards basic salts at the same time; sol. in aqua regia, forming HgCl_2; combines with the halogens and S at ordinary temp.; with most metals it forms amalgams, i. e., alloys that are liquid or solid according as Hg or the other metal is in excess; amalgams may be considered solns. of metals in Hg. At. No. 80; At. Wt. 200.61; Mol. Wt. the same; val. 1 and 2; sp. gr. 13.546 for the liquid, 14.19 for the solid; M. P. 38.87°; boils at 356.90°; but volatilizes very easily; sl. volatile even at ordinary temp.; 2 or 6 isotopes.

Copper	Cadmium	Bismuth	Metal
Cu, copper. Reddish yellow, very ductile, malleable, elastic, sonorous, somewhat tenacious metal; takes a good polish, but does not keep it; rather hard, but may be cut with a knife; transmits green light in thin leaflets; sometimes occurs as cubes or octahedra; usually found in ingots, sheets, leaf, wire or powder; finely divided Cu may readily be hammered and pressed into masses; expands when solidifying from molten condition; stable in dry air, but turns dull; in moist air it gradually becomes coated with a green basic Cu carbonate; forms black CuO when heated in air or O₂; decomp. water only at bright red heat, and then only slowly; very sl. sol. in HCl; slowly sol. in dil. H₂SO₄; hot concd. H₂SO₄ dissolves Cu, evolving SO₂ and leaving CuSO₄; very concd. HNO₃ renders Cu passive; concd. HNO₃ evolves NO₂; dil. HNO₃ dissolves it readily to Cu(NO₃)₂, evolving NO; sl. sol. in HC₂H₃O₂ and other organic acids; sl. acted on by food juices in the presence of air; slowly sol. in NH₄OH to a blue liquid containing Cu oxide-ammonia; combines directly with the halogens and S; alloys itself easily with other metals; pptd. from aq. Cu solns. by Fe or Zn as dark brown, non-lustrous powder; Cu compounds color the borax or salt of phosphorus bead greenish blue in the oxidizing flame, but red and opaque in the reducing flame. At. No. 29; At. Wt. 63.57; Mol. Wt. unknown, perhaps 127.14; val. 2; sp. gr. 8.92; M. P. 1083°; vaporizes at white heat; B. P. 2300°; 2 isotopes.	Cd, cadmium. Silver-white, bluinged, highly lustrous, tenacious, very malleable, ductile, flexible metal; sl. harder than Zn; more tenacious than Sn; cryst. easily in octahedra; occurs in bars, sheets, ribbon and powder; vapor is yellow; oxidizes slowly and superficially in air to brown CdO; does not decomp. water; sol. with difficulty in dil. HCl or H₂SO₄; easily sol. in HNO₃; sol. in HC₂H₃O₂; combines directly with the halogens and S; forms an amalgam with Hg and alloys with many other metals. At. No. 48; At. Wt. 112.41; Mol. Wt. the same; val. 2; sp. gr. 8.6; M. P. 320.9°; B. P. 767°; 6 isotopes.	Bi, bismuth. Grayish white metal with reddish tinge; hard, highly lustrous, brittle; cryst. very easily; expands as it solidifies; forms with other metals numerous alloys that melt at lower temp. than Bi and expand when solidifying; occurs in lumps or powder; may be distilled above 1100° in an atmosphere of H₂; very superficially oxidized in ordinary air; burns at high temp. in air or O₂ to Bi₂O₃; decomp. steam at red heat; not affected by water; very sl. acted on by HCl, dil. or concd., hot or cold; insol. in dil. H₂SO₄; acted on by hot, concd. H₂SO₄, with formation of SO₂ and a basic Bi sulfate; easily sol. in dil. or concd. HNO₃, forming Bi(NO₃)₃; sol. in aqua regia to BiCl₃; unites with the halogens and S. At. No. 83; At. Wt. 209.00; Mol. Wt. probably the same; val. 3 and 5; sp. gr., 9.8; M. P. 271°; B. P. 1450°; vaporizes easily at 1700°; 1 isotope.	

Ag, Pb, Hg, Cu, Cd, Bi GROUP

Acetate

Silver	Lead	Mercury(ous)	Mercury(ic)
$\text{AgC}_2\text{H}_3\text{O}_2$, <i>silver acetate</i>. Small, flat needles, flexible laminæ, or microscopic, cryst. powder; mother-of-pearl luster; sol. in boiling water; decomp. when heated; sp. gr. 3.3.	$\text{Pb}(\text{C}_2\text{H}_3\text{O}_2)_2$. $3\text{H}_2\text{O}$, <i>lead acetate</i>, <i>normal plumbic acetate</i>, <i>sugar of lead</i>, <i>salt of Saturn</i>, <i>plumbic acetate</i>, <i>normal lead acetate</i>, <i>brown acetate</i>, <i>brown sugar of lead</i>, <i>Goulard powder</i>, <i>sugar of Saturn</i>. Colorless, shiny, transparent, monoclinic prisms, flat cryst. or white powder; acetous odor; sweet metallic taste; easily sol. in water, 5 g. in 100 g. of water at 25°; easily sol. in ordinary alcohol; insol. in cold, abs. alcohol but completely dehydrated by long boiling with abs. alcohol; the aq. soln. is partially decomp. by the CO_2 in the air, PbCO_3 being pptd.; melts at 75°; begins to give off its cryst. water and some $\text{HC}_2\text{H}_3\text{O}_2$ at a little above 100°; is completely dehydrated at 280° and decomp. above 280°, leaving very finely divided and highly combustible Pb; sp. gr. 2.6. $\text{Pb}(\text{C}_2\text{H}_3\text{O}_2)_2$. 2PbO, <i>basic lead acetate</i>, <i>lead vinegar</i>. White, lustrous, silky microscopic needles or white powder; sol. in water; insol. in abs. alcohol. Two other basic acetates said to exist.	$\text{Hg}_2(\text{C}_2\text{H}_3\text{O}_2)_2$, <i>mercury acetate</i>, <i>mercurous acetate</i>. White powder or micaceous scales; darkens on exposure; sl. sol. in water.	$\text{Hg}(\text{C}_2\text{H}_3\text{O}_2)_2$, <i>mercury acetate</i>, <i>mercuric acetate</i>. White powder or lustrous, micaceous scales; acetic acid odor; sol. in water; decomp. when heated; sp. gr. 3.3.

Arsenate

Ag_3AsO_4, <i>silver arsenate</i>, <i>silver arseniate</i>. Black, opaque, lustrous, regular cryst. or dark reddish brown ppt.; insol. in water; sol. in NH_4OH,	$\text{Pb}_3(\text{AsO}_4)_2$, <i>lead arsenate</i>, <i>lead arseniate</i>. White, fusible powder; turns yellow when heated; insol. in water, NH_4OH and NH_3 salt solns.; sol. in ac-	Hg_3AsO_4, (?) <i>mercury arsenate</i>, <i>mercurous arsenate</i>, <i>mercury arseniate</i>. Yellowish white ppt. that changes to orange-red on standing; insol. in water; sol. in	$\text{Hg}_2(\text{AsO}_4)_2$, (?) <i>mercury arsenate</i>, <i>mercuric arsenate</i>, <i>mercury arseniate</i>. Brownish yellow to dirty, red-brown powder; insol. in water; sparingly sol. in HNO_3; eas-
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Copper(cuprous)	Copper(cupric)	Cadmium	Bismuth	
$\text{Cu}_2(\text{C}_2\text{H}_3\text{O}_2)_2$, <i>cuprous acetate</i>, <i>cuprous acetate</i>. Soft, loose, white flakes with acid reaction and caustic, astringent taste; decomp. by water to Cu_2O and normal cupric acetate.	$\text{Cu}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot \text{H}_2\text{O}$, <i>copper acetate</i>, <i>cupric acetate</i>, <i>normal cupric acetate</i>, <i>crystallized verdigris</i>, <i>crystals of Venus</i>. Large, dark green, monoclinic, efflor. cryst. or green, cryst. powder or warty masses; acetic acid odor; metallic taste; melts at 115° with decomp.; sol. in water; sl. sol. in alcohol; sp. gr. 1.9. $\text{Cu}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot \text{CuO}$, <i>basic copper acetate</i>, <i>dibasic cupric acetate</i>, <i>blue verdigris</i>, <i>French verdigris</i>. Delicate, silky, blue, cryst. needles or scales; or very fine, light blue powder; metallic taste; sol. in water; loses its cryst. water at 60°, and then decomp. to a green mass. $2\text{Cu}(\text{C}_2\text{H}_3\text{O}_2)_2$. $\text{CuO} \cdot 6\text{H}_2\text{O}$, <i>sesquibasic cupric acetate</i>, <i>green verdigris</i>. Green, amorph. powder. <i>Common verdigris</i> is a mixture of the blue and green varieties.	$\text{Cd}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot 3\text{H}_2\text{O}$, <i>cadmium acetate</i>. Colorless, deliq., monoclinic, prismatic cryst., very easily sol. in water; cryst. with difficulty.	$\text{Bi}(\text{C}_2\text{H}_3\text{O}_2)_3$, <i>bismuth acetate</i>. Mucaceous laminae or white powder; loses acetic acid on exposure, especially when warm; sol. in $\text{HC}_2\text{H}_3\text{O}_2$.	Acetate
Unknown.	$\text{Cu}_3(\text{AsO}_4)_2 \cdot 4\text{H}_2\text{O}$, <i>copper arsenate</i>, <i>cupric arsenate</i>, <i>copper arseniate</i>. Blue or green, amorph. powder; insol. in water; sol. in acids and NH_4OH.	$\text{Cd}_3(\text{AsO}_4)_2$, <i>cadmium arsenate</i>, <i>cadmium arseniate</i>. White, voluminous ppt.	$2\text{BiAsO}_4 \cdot \text{H}_2\text{O}$, <i>bismuth arsenate</i>, <i>bismuth arseniate</i>. White, tasteless powder; insol. in water and HNO_3; sol. in HCl; melts with difficulty.	Arsenate

Ag, Pb, Hg, Cu, Cd, Bi GROUP

	Silver	Lead	Mercury(ous)	Mercury(ic)
Arsenate <i>Cont.</i>	$(\text{NH}_4)_2\text{CO}_3 + \text{Aq.}$ HNO_3 and $\text{HC}_2\text{H}_3\text{O}_2$; decomp. by HCl ; melts to a brownish red mass.	ids; M. P. 1042° ; sp. gr. 7.3.	HNO_3 ; decomp. by HCl .	ily sol. in HCl ; sl. sol. or insol. in $\text{H}_2\text{AsO}_4 + \text{Aq.}$
Arsenite	Ag_3AsO_3 , <i>silver ar-</i> <i>senite</i> . Fine, yel- low powder; de- comp. by heat; darkens in the light; insol. in wa- ter; sol. in NH_4OH and HNO_3 .	$\text{Pb}_3(\text{AsO}_3)_2$, <i>lead</i> <i>arsenite</i> . White ppt. first granular, then voluminous; darkens in the light; sparingly sol. in water; eas- ily sol. in HNO_3 and $\text{HC}_2\text{H}_3\text{O}_2$.	Hg_3AsO_3 , (?) <i>mercury arsenite</i> , <i>mercurous arse-</i> <i>nite</i> . Unstable, white or grayish yellow powder; sol. in HNO_3 .	$\text{Hg}_3(\text{AsO}_3)_2$, (?) <i>mercury arsenite</i> , <i>mercuric arsenite</i> . White powder; sol. in HNO_3 or in soln. of potassium ar- senite.
Borate	$2\text{AgBO}_2 \cdot \text{H}_2\text{O}$, <i>sil-</i> <i>ver borate</i> . White to yellowish pow- der; sl. sol. in wa- ter with decomp.; easily sol. in HNO_3 .	$\text{Pb}(\text{BO}_2)_2 \cdot \text{H}_2\text{O}$, <i>lead borate</i> . White powder; insol. in water; easily sol. in HNO_3 or boil- ing $\text{HC}_2\text{H}_3\text{O}_2$; de- comp. by H_2SO_4 and HCl ; also by boiling KOH or NaOH ; insol. in alcohol.	$\text{Hg}_2\text{B}_4\text{O}_7$, <i>mercury</i> <i>borate</i> , <i>mercurous</i> <i>tetraborate</i> , <i>mer-</i> <i>curous pyroborate</i> . Brown powder.	Unknown.

Ag, Pb, Hg, Cu, Cd, Bi GROUP

Copper(cuprous)	Copper(cupric)	Cadmium	Bismuth	
	$\text{Cu}_2(\text{AsO}_4)_2 \cdot 5\text{H}_2\text{O}$, <i>cupric arsenate</i> . Green needles with silky luster; easily sol. in HCl.			Arsenate <i>Cont.</i>
Unknown.	$\text{Cu}_3(\text{AsO}_3)_2$, <i>cop- per arsenite, cupric arsenite, copper or- thoarsenite, normal copper arsenite</i> . Yellowish green powder; sol. in al- kalies; sl. sol. in water. CuHAsO_3 , <i>acid copper arsenite, Scheele's green, Swedish green, mineral green</i> . Fine, light green powder; insol. in water; sol. in HNO_3 or NH_4OH ; also in KOH soln., with blue color; when heated de- comp. to H_2O and oxides of arsenic and copper. $3\text{Cu}(\text{AsO}_2)_2$. $\text{Cu}(\text{C}_2\text{H}_3\text{O}_2)_2$, <i>cop- per aceto-arsenite, Schweinfurth's green, Imperial green, Paris green, emerald green, Vi- enna green, verdi- gris green, emper- or green, mineral green, parrot green, Kaiser green, Eng- lish green, patent green</i> . Emerald green, finely cryst. powder; very poi- sonous; insol. in water; when boiled with water gives up acetic acid and be- comes brown; sol. in acids with de- comp.	Unknown.	Unknown.	Arsenite
Unknown.	$\text{Cu}(\text{BO}_2)_2$, (?) <i>cop- per borate, cupric borate</i> . Bluish green, cryst. pow- der of a variable compn.; sol. in wa- ter.	$\text{Cd}(\text{BO}_2)_2$, <i>cadmi- um borate</i> . White powder; difficultly sol. in water.	BiBO_3 , (?) <i>bis- muth borate</i> . White powder; in- sol. in water; sol. in acids.	Borate

Ag, Pb, Hg, Cu, Cd, Bi GROUP

	Silver	Lead	Mercury(ous)	Mercury(ic)
Bromate	AgBrO₃, silver bromate. Colorless, tetragonal cryst. or heavy, white powder; decomp. by heat; insol. in water and HNO ₃ ; sol. in NH ₄ OH; sp. gr. 5.2.	Pb(BrO₃)₂·H₂O, lead bromate. Small, lustrous, monoclinic cryst. or white powder; somewhat sol. in water; decomp. at 180°; sp. gr. 5.5.	Hg₂(BrO₃)₂, mercury bromate, mercurous bromate. White powder or small tablets; detonates when heated; boiling water forms a basic bromate; difficultly sol. in HNO ₃ ; easily sol. in HCl.	Hg(BrO₃)₂·2H₂O, mercury bromate, mercuric bromate. White powder or small prisms; decomp. when heated; sl. sol. in water; difficultly sol. in HNO ₃ ; sol. in HCl, with decomp.
Bromide	AgBr, silver bromide, bromyrite. Yellow to olive-green, regular, octahedral cryst.; or white or dark lemon-yellow ppt.; color changes very slowly to violet when exposed to light; insol. in water; not attacked by boiling HNO ₃ ; sl. sol. in concd. HBr or HCl; very sl. sol. in dil., easily sol. in concd. NH ₄ OH; slowly sol. in hot AgNO ₃ soln.; melts at 432° to a reddish liquid; sp. gr. 6.5.	PbBr₂, lead bromide. White, cryst. powder or white, lustrous, rhombic needles; sl. sol. in cold, more easily sol. in hot water, 0.5 g. in 100 g. of water at 0°, 0.9 g. at 25°, 4.7 g. at 100°, or in water containing a little HCl, HNO ₃ or HC ₂ H ₃ O ₂ ; slowly sol. in cold, easily sol. in warm NH ₄ Cl+Aq or NH ₄ NO ₃ +Aq; decomp. by H ₂ SO ₄ or HNO ₃ ; M. P. 373°; after melting solidifies to a horn-like mass; sp. gr. 6.6.	Hg₂Br₂, mercury bromide, mercurous bromide. Fibrous masses; or long needles, yellow when warm, white when cold; or white, tetragonal leaflets, with mother-of-pearl luster or white powder; odorless and tasteless; insol. in water; sol. in H ₂ SO ₄ , with evolution of SO ₂ ; slowly sol. in hot HNO ₃ ; decomp. by hot HCl, dil. or concd.; decomp. by NH ₄ OH or KOH+Aq; slowly decomp. by KBr+Aq; sol. in some NH ₄ salt solns.; M. P. 340° to 350°; sp. gr. 7.3.	HgBr₂, mercury bromide, mercuric bromide. Slender, silvery, lustrous, tetragonal leaflets or white needles; rhombic prisms or rhombic pyramids; acid reaction; sol. in water; decomp. by warm HNO ₃ or warm, dil. H ₂ SO ₄ ; easily sol. in alcohol; melts and sublimes at high temp.; M. P. 237°; sp. gr. 6.
Carbide	Ag₂C, silver carbide, silver tetrithiocarbide. Of doubtful existence. Ag₂C, silver carbide, silver hemithiocarbide. Yellow powder; sol. in dil. HNO ₃ , leaving a residue of C. Ag₂C₂, silver carbide, silver acetylide. Dark brown metal-like powder; pale yellow ppt. from dil. soln., yellow from concd. soln.; turns white on standing; sol. in dil. HNO ₃ , leaving a residue of C; explodes when dry; turns gray on exposure to light; reacts	PbC₂, lead carbide. Of doubtful existence; said to be a grayish powder, stable in air and water but decomp. by dil. HCl.	Hg₂C₂·H₂O, mercury carbide, mercurous carbide. White if pure, gray if a little Hg is present; water cannot be removed; decomp. when heated to 100°; probably explosive; insol. in water and alcohol.	HgC₂, mercury carbide, mercuric carbide. White flocculent ppt. or powder; insol. in water, alcohol and ether; turns dark and decomp. at 100°; explodes if heated rapidly; sol. in HCl and HNO ₃ ; explosive in contact with Cl ₂ or Br ₂ ; explosive when mixed with concd. H ₂ SO ₄ ; only sl. affected by dil. H ₂ SO ₄ ; sp. gr. 5.3.

Ag, Pb, Hg, Cu, Cd, Bi GROUP

Copper(cuprous)	Copper(cupric)	Cadmium	Bismuth	
Unknown.	$\text{Cu}(\text{BrO}_3)_2 \cdot 6\text{H}_2\text{O}$, <i>copper bromate, cupric bromate</i> . Indefinite blue-gray cryst. or greenish white powder; easily sol. in water; loses its cryst. water completely and some Br_2 at 200° ; sp. gr. 2.6.	$\text{Cd}(\text{BrO}_3)_2 \cdot 2\text{H}_2\text{O}$, <i>cadmium bromate</i> . Transparent, rhombic prisms; somewhat sol. in water; decomp. when heated.	$2\text{Bi}_2\text{O}_3 \cdot 2\text{Br}_2\text{O}_5 \cdot 6\text{H}_2\text{O}$, <i>basic bismuth bromate</i> . White, amorph. powder; loses its cryst. water at 150° to 160° ; decomp. at higher temp. with great violence.	Bromate
Cu_2Br_2 , <i>copper bromide, cuprous bromide</i> . Molten, grayish brown or greenish brown, cryst. masses; translucent in thin pieces; or white powder; insol. in water; sol. in halogen acids, NH_4OH , $\text{NaCl} + \text{Aq}$ and $\text{Na}_2\text{S}_2\text{O}_3 + \text{Aq}$; sol. in HNO_3 with decomp.; insol. in boiling, concd. H_2SO_4 or in $\text{HC}_2\text{H}_3\text{O}_2$; M. P. 504° ; sp. gr. 4.7.	CuBr_2 , <i>copper bromide, cupric bromide</i> . Black, deliq. cryst. resembling iodine, or black masses resembling graphite; very sol. in water; M. P. 298° .	$\text{CdBr}_2 \cdot 4\text{H}_2\text{O}$, <i>cadmium bromide</i> . Long, white or colorless needles that efflor. rapidly on exposure; loses all its cryst water at 200° ; sol. in water. CdBr_2 , <i>anhydrous cadmium bromide</i> . White, lustrous, non-hygroscopic, cryst. solid; or white leaflets with pearly luster; very sol. in water, 38 g. in 100 g. of soln. at 0° , 49 g. at 18° , 61 g. at 100° ; sol. in HCl , $\text{HC}_2\text{H}_3\text{O}_2$, and alcohol; M. P. 583° ; sp. gr. 5.2.	BiBr_3 , <i>bismuth bromide, bismuth tribromide</i> . Steel-gray, sulfur-yellow or orange-yellow, radiated, cryst. masses; or flat, yellow, lustrous prisms; very deliq.; decomp. by water, with the formation of a yellowish white powder, bismuth oxybromide, BiOBr ; sol. in HCl or alcohol; melts at 439° to a red liquid; sp. gr. 5.7. Bi_2Br_4 , <i>bismuth bromide, bismuth dibromide</i> . Brown mass; not known in the pure state.	Bromide
Cu_2C_2 , <i>copper carbide, cuprous carbide, cuprous acetylide</i> . Red, reddish brown or brown, voluminous ppt.; unstable in air; probably explosive; insol. in water; sol. in very dil. HCl ; decomp. by concd. HCl ; sol. with decomp. in dil. H_2SO_4 ; sol. in cold dil., decomp. by concd. HNO_3 ; insol. in aq. solns. of alkali hydroxides.	CuC_2 , <i>copper carbide, cupric carbide, cupric acetylide</i> . Deep red ppt.; turns brownish black in air; sol. in HCl . Other copper acetylides of varying compn. are said to exist.	Unknown.	Unknown.	Carbide

Ag, Pb, Hg, Cu, Cd, Bi GROUP

	Silver	Lead	Mercury(ous)	Mercury(ic)
Carbide <i>Cont.</i>	with HCl forming AgCl and C ₂ H ₂ .			
Carbonate	Ag ₂ CO ₃ , <i>silver carbonate</i> . White, curdy ppt. or amorph. powder, becoming yellow on washing and dark when exposed to light; or transparent, lemon-yellow needles or rhombohedrons; unchanged by cold water, but decomp. by hot water, with formation of Ag ₂ O; sol. in HNO ₃ , NH ₄ OH, (NH ₄) ₂ CO ₃ +Aq, and Na ₂ S ₂ O ₃ +Aq; decomp. by HCl and chloride solns.; insol. in alcohol; decomp. at 200° into CO ₂ and Ag ₂ O.	PbCO ₃ , <i>lead carbonate, ceruse, cerusite, lead spar, normal lead carbonate</i> . Colorless, transparent, highly lustrous, rhombic or small, six-sided tablets; or white powder; nearly insol. in water; easily sol. in acids, even HC ₂ H ₃ O ₂ ; sol. in NH ₄ Cl+Aq or NH ₄ C ₂ H ₃ O ₂ +Aq; completely decomp. at 315°; sp. gr. 6.6. 2PbCO ₃ .Pb(OH) ₂ , <i>basic lead carbonate, white lead, flaked lead, lead flake, hydrocerusite, cremnitz white, silver white, London white, Nottingham white, magister of lead</i> . Perfectly white, heavy, amorph. masses or powder; insol. in water; sol. in HC ₂ H ₃ O ₂ , dil. HNO ₃ and cold, dil. NH ₄ Cl+Aq; decomp. by heat.	Hg ₂ CO ₃ , <i>mercury carbonate, mercurous carbonate</i> . Yellow powder that loses CO ₂ and turns dark on exposure; decomp. by hot water; sol. in acids with decomp.; sol. in hot NH ₄ Cl+Aq.	Normal salt unknown. 4HgO.CO ₂ , <i>basic mercuric carbonate</i> . Ochre-brown, amorph. powder; not affected by water. 3HgO.CO ₂ , <i>basic mercuric carbonate</i> . Dark brown, amorph. powder; insol. in water; sol. in NH ₄ Cl+Aq; somewhat sol. in H ₂ CO ₃ or K ₂ CO ₃ +Aq.
Chlorate	AgClO ₃ , <i>silver chlorate</i> . Long, white, opaque, four-sided prisms; stable in air; somewhat sol. in cold, more sol. in hot water, 10 to 20 g. in 100 g. of water; sl. sol. in alcohol; melts at 230°; decomp. at 270°; sp. gr. 4.4.	Pb(ClO ₃) ₂ , <i>lead chlorate</i> . White, lustrous scales or long, monoclinic prisms, which become dull and opaque in air; deliq.; easily sol. in water, 151 g. in 100 g. of water at 18°; easily sol. in alcohol; decomp. at 230°; sp. gr. 3.9.	Hg ₂ (ClO ₃) ₂ , <i>mercury chlorate, mercurous chlorate</i> . Beautiful, lustrous, inch-long rhombic prisms when freshly made, rapidly becoming opaque in air; sol. in water or alcohol; explodes with combustible substances; decomp. by heat.	2HgO.Cl ₂ O ₃ .H ₂ O, <i>mercury chlorate, mercuric chlorate</i> . Small, rhombic needles or octahedra; deliq.; sol. in water; decomp. by heat.

Copper(cuprous)	Copper(cupric)	Cadmium	Bismuth	Carbide Cont. Carbonate
Unknown.	Normal salt unknown. $\text{CuCO}_3 \cdot \text{Cu}(\text{OH})_2$, basic cupric carbonate, malachite, mineral green, Bremen green, Brunswick green, mountain green, Victoria green. Grass-green, monoclinic cryst., fibrous masses or heavy, green powder; ppt. is greenish blue at first, but on standing in the liquid becomes dark green; insol. in water; easily sol. in acids, even H_2SO_4; sol. in NH_4OH and NH_4 salt solns.; decomp. at 220°. $2\text{CuCO}_3 \cdot \text{Cu}(\text{OH})_2$, basic cupric carbonate, azurite, verditer blue, blue malachite, Bremen blue, mountain blue, blue ashes, azure blue, mineral blue, copper blue, Hamburg blue, English blue, Bremen green, verditer green. Deep azure blue, highly lustrous, monoclinic cryst. or compact, cryst. masses; insol. in water; sol. in NH_4OH and in hot. concd. $\text{NaHCO}_3 + \text{Aq}$ to a blue color; decomp. at 300°.	CdCO_3, cadmium carbonate. White amorph. powder; insol. in water; easily sol. in acids with decomp.; sol. in NH_4 salt solns. and in $\text{KCN} + \text{Aq}$.	Normal salt unknown. $(\text{BiO})_2\text{CO}_3$, basic bismuth carbonate, bismuth oxycarbonate, bismuth subcarbonate. White, tasteless powder; insol. in water; sol. in acids with decomp.; insol. in $(\text{NH}_4)_2\text{CO}_3 + \text{Aq}$.	
Unknown.	$\text{Cu}(\text{ClO}_3)_2 \cdot 6\text{H}_2\text{O}$, copper chlorate, cupric chlorate. Beautiful green, regular octahedra; very deliq.; easily sol. in water, 58 g. of the anhydrous salt in 100 g. of soln. at 0°, 62 g. at 18°, 77 g. at 71°; acid reaction; easily sol. in alcohol; melts in its cryst. water at 65°; de-	$\text{Cd}(\text{ClO}_3)_2 \cdot 2\text{H}_2\text{O}$, cadmium chlorate. Colorless, very deliq., prismatic cryst.; easily sol. in water, 75 g. of the anhydrous salt in 100 g. of soln. at 0°, 76 g. at 18°, 83 g. at 65°; easily sol. in alcohol; melts in its cryst. water at 80° with decomp.	$\text{Bi}(\text{ClO}_3)_3$, (?) bismuth chlorate. Known only in soln., which decomp. on evaporation.	Chlorate

Ag, Pb, Hg, Cu, Cd, Bi GROUP

Chlorate
Cont.

Chloride

Silver	Lead	Mercury(ous)	Mercury(ic)
AgCl, <i>silver chloride, butter of silver, cerargyrite, horn silver, chlorargyrite</i>. Pearl gray, almost colorless, highly lustrous, translucent, flexible, regular cryst.; or white, curdy ppt.; or white, powder; both ppt. and powder darken when exposed to light; nearly insol. in water and dil. HNO_3; sol. in concd. HCl; sol. in solns. of nitrates of alkali metals; easily sol. in $\text{Na}_2\text{S}_2\text{O}_3 + \text{Aq}$ and in $\text{KCN} + \text{Aq}$; sl. sol. in hot alcohol to which HCl has been added, but repts. on cooling; M. P. c. 455°; sp. gr. 5.6.	PbCl₂, <i>lead chloride, horn lead, cotunnite</i>. White, lustrous, rhombic needles or scales; or white, cryst. powder, or white amorph. powder; sparingly sol. in cold water; sol. in hot water, 0.7 g. in 100 g. of water at 0°, 1 g. at 25°, 3.3 g. at 100°; sol. in concd. HCl; sol. in dil. HNO_3 from which it is pptd. by HCl; easily and completely decomp. by hot HNO_3; sol. in $\text{KOH} + \text{Aq}$ and in $\text{Na}_2\text{S}_2\text{O}_3 + \text{Aq}$; easily sol. in $\text{NH}_4\text{NO}_3 + \text{Aq}$; much more sol. in $\text{HgCl}_2 + \text{Aq}$ than in water; insol. in abs., sl. sol. in dil. alcohol; M. P. 501°; sp. gr. 5.8. PbOCl (?), <i>lead orychloride, Turner's yellow, patent yellow, Cassel yellow, Verona yellow, Turin yellow, Montpellier yellow, mineral yellow, Paris yellow, English yellow</i>. Of varying compn.; insol. in water.	Hg₂Cl₂, <i>mercury chloride, mercurous chloride, mercury monochloride, calomel, sublimed calomel, precipitated calomel, flystone, horn quicksilver</i>. Colorless, quadratic or microscopic needles; or white, impalpable, heavy powder or lumps; tasteless and odorless; darkens when exposed to sunlight, with separation of Hg; almost absolutely insol. in cold, but gradually sl. decomp. by boiling water; sol. in concd. HCl; sol. in cold $\text{HCN} + \text{Aq}$, with separation of Hg; sol. in alkali chloride solns.; decomp. by NH_4OH, $\text{NaOH} + \text{Aq}$, and $\text{KOH} + \text{Aq}$; insol. in alcohol; sublimes at 400° to 500°; M. P. 302°; sp. gr. 7.2.	HgCl₂, <i>mercury chloride, mercuric chloride, mercury bichloride, corrosive sublimate, sublimate, stone mercury</i>. White heavy, transparent, fragile, cryst. masses; or colorless, lustrous rhombic cryst. or needles; or white powder; acrid, persistent, metallic taste; poisonous; sol. in water, 3.5 g. in 100 g. of soln. at 0°, 5 g. at 20°, 38 g. at 100°; sol. in hot, concd. HCl; sol. in H_2SO_4 or HNO_3 without decomp.; easily sol. in alcohol; melts at 277° to a colorless liquid; sublimes at c. 300°; sp. gr. 5.4. HgOCl (?), <i>mercury oxychloride, terlingwaite, egglestonite</i>. Several are known.

Copper(cuprous)	Copper(cupric)	Cadmium	Bismuth
	comp. at higher temp.		
Cu_2Cl_2, <i>copper chloride, cuprous chloride, copper monochloride, nanthokite</i>. White, cryst. powder that consists of small, colorless tetrahedrons; when moist changes in sunlight and air to yellow, then dirty violet, and finally to blue-black; insol. in water, H_2SO_4 and dil. HNO_3; sol. in concd. HCl; insol. in alcohol; when cooled slowly solidifies to translucent, bright yellow, cryst. masses; when cooled rapidly, solidifies to dark brown masses; when heated in air forms a white vapor; M. P. 422°; sp. gr. 3.5.	$\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$, <i>copper chloride, cupric chloride, copper bichloride</i>. Long, green needles; rhombic cryst. with prismatic habit; deliq. in moist air; sol. in water; the soln. in a little water is dark brown, in somewhat more water emerald green, in much water pale blue; the blue soln. becomes green on boiling, and the green soln. becomes blue in a freezing mixture; H_2SO_4 withdraws the cryst. water without decomp. the salt; melts at moderate heat, losing its cryst. water; M. P. 110°; sp. gr. 2.4. CuCl_2, <i>anhydrous cupric chloride</i>. Yellowish brown powder or brown sublimate; deliq.; easily sol. in water, 41 g. in 100 g. of soln. at 0°, 43 g. at 20°, 52 g. at 100°; sol. in alcohol; M. P. 498°; sp. gr. 3. $\text{CuCl}_2 \cdot 3\text{CuO} \cdot 4\text{H}_2\text{O}$, <i>cupric oxychloride, Brunswick green</i>. Emerald-green, grass-green or greenish black, translucent, highly lustrous, rhombic cryst.; or loose, pale green powder; insol. in cold water; decomp. by boiling water; sol. in acids and NH_4OH. $\text{CuCl}_2 \cdot 3\text{CuO}$, <i>anhydrous cupric oxychloride</i>. Brown powder; other properties similar to the hydrous salt.	$\text{CdCl}_2 \cdot 2\text{H}_2\text{O}$, <i>cadmium chloride, butter of cadmium</i>. Long, transparent, right-angled prisms, which easily efflor. and sublime when heated; easily sol. in water; insol. in HCl; readily sol. in alcohol. CdCl_2, <i>anhydrous cadmium chloride</i>. Transparent masses with pearly luster; or micaceous scales, which change to white powder when exposed to air; very sol. in water, 47 g. in 100 g. of soln. at 0°, 52 g. at 18°, 59 g. at 100°; insol. in concd. HCl; M. P. 565°; B. P. 861° to 954°; sp. gr. 4.	Bi_2Cl_3, <i>bismuth chloride, bismuthous chloride, bismuth dichloride</i>. Black, extremely deliq., masses of earthy fracture; decomp. by water, dil. acids or concd. $\text{NH}_4\text{Cl} + \text{Aq}$, with formation of BiOCl; decomp. to BiCl_3 and Bi when heated to 300°. BiCl_3, <i>bismuth chloride, bismuthic chloride, bismuth trichloride, butter of bismuth</i>. White, cryst. masses or beautiful cryst.; very deliq. in moist air; sol. in a small quantity of water, in dil. HCl, and in alcohol; much water produces BiOCl; not decomp. by water in presence of citrates; volatilizes easily; M. P. 230°; sublimes at c. 428°; sp. gr. 4.7. BiOCl, <i>bismuth oxychloride, bismuthyl chloride, pearl white, cosmetic bismuth, flake white</i>. White, lustrous, cryst. powder; insol. in water and in dil. acids; sol. in concd. HCl and in concd. HNO_3; melts at red heat without decomp.

Chlorate
Cont.

Chloride

Ag, Pb, Hg, Cu, Cd, Bi GROUP

Chloride
Cont.

Chromate

Silver	Lead	Mercury(ous)	Mercury(ic)
Ag₂CrO₄, <i>silver chromate</i>. Dark red cryst. or brownish red, cryst. powder; insol. in water; sol. in acids, NH₄OH, and in solns. of alkali chromates. Ag₂Cr₂O₇, <i>silver dichromate</i>, <i>silver bichromate</i>. Small, red, triclinic cryst.; sol. in water; easily sol. in HNO₃ and in NH₄OH; decomp. by boiling with water into CrO₃ and Ag₂CrO₄.	PbCrO₄, <i>lead chromate</i>, <i>chrome yellow</i>, <i>red-lead ore</i>, <i>crocoite</i>, <i>crocoisite</i>, <i>lead yellow</i>, <i>Leip-sic yellow</i>, <i>lemon yellow</i>, <i>Paris yellow</i>, <i>canary yellow</i>, <i>Cologne yellow</i>, <i>royal yellow</i>, <i>new yellow</i>, <i>American chrome yellow</i>, <i>French chrome yellow</i>, <i>Baltimore chrome yellow</i>, <i>King's yellow</i>, <i>imperial yellow</i>. Fine, lemon-yellow, amorph. powder; or brown powder, brownish black lumps or brown, radiated, cryst. masses when fused; insol. in water; sol. in dil. H₂SO₄; sl. sol. in HNO₃; easily decomp. by hot HCl; insol. in HCl, H₂O₂; sol. in NaOH, KOH and K₂Cr₂O₇ + Aq; melts to a brown liquid when heated. PbCrO₄.PbO, <i>basic lead chromate</i>, <i>chrome red</i>, <i>chrome orange</i>, <i>American vermilion</i>, <i>Austrian cin-nabar</i>, <i>Chinese red</i>, <i>chromate red</i>, <i>Persian red</i>, <i>Victoria red</i>, <i>chrome cinna-bar</i>, <i>chrome gar-net</i>, <i>chrome ruby</i>, <i>chrome carmine</i>. Red cryst. or fine, red, cryst. powder; insol. in water; sol. in KOH + Aq. PbCr₂O₇, <i>lead dichromate</i>, <i>lead bi-chromate</i>. Brick-red, cryst. powder; decomp. by water.	Hg₂CrO₄, <i>mercury chromate</i>, <i>mercur-ous chromate</i>. Beautiful red powder; very sl. sol. in cold, more readily sol. in hot water; sl. sol. in dil., more sol. in concd. HNO₃; sol. in KCN + Aq; when heated decomp. to the beautiful green Cr₂O₃, O₂ and Hg.	HgCrO₄, <i>mercury chromate</i>, <i>mercuric chromate</i>. Dark red powder or dark garnet-red prisms; decomp. by water; sol. in acids, NH₄Cl + Aq and NH₄NO₃ + Aq.
AgCN, <i>silver cyanide</i>. White, curdy ppt. or white, odorless, tasteless pow-	Pb(CN)₂, <i>lead cyanide</i>. Heavy, white ppt. or powder; nearly insol.	Unknown.	Hg(CN)₂, <i>mercury cyanide</i>, <i>mercuric cyanide</i>. Long, colorless, transpar-

Cyanide

Ag, Pb, Hg, Cu, Cd, Bi GROUP

Copper(cuprous)	Copper(cupric)	Cadmium	Bismuth	Chloride Cont.
	Two other oxy-chlorides are said to exist.			
Unknown.	Normal salt unknown. CuCrO₄.2CuO.2H₂O , <i>basic cupric chromate</i> . Light, chocolate-brown powder or yellowish brown ppt.; insol. in water; easily sol. in dil. HNO ₃ and in NH ₄ OH; decomp. by KOH; loses its cryst. water at 260° and takes it up again in moist air. CuCr₂O₇.2H₂O , <i>copper dichromate, cupric dichromate, copper bichromate</i> . Reddish brown, brown, or brownish black, deliq. cryst.; very easily sol. in cold water, but decomp. by boiling water; sol. in NH ₄ OH or alcohol.	Normal salt unknown. 2CdO.CrO₃.H₂O , <i>basic cadmium chromate</i> . Fine, yellow powder; very sl. sol. in water; very slowly sol. in NH ₄ OH; sol. in acids.	Normal salt unknown. xBi₂O₃.yCrO₃ , <i>basic bismuth chromate</i> . Several are known; generally yellow to red, heavy, cryst. or amorph. powders; insol. in water; sol. in HCl or HNO ₃ ; slowly decomp. by hot acids.	Chromate
Cu₂(CN)₂ , <i>copper cyanide, cuprous cyanide</i> . White to greenish white	Cu(CN)₂ , <i>copper cyanide, cupric cyanide</i> . Yellow or brownish yellow	Cd(CN)₂ , <i>cadmium cyanide</i> . Small, white cryst. or fine, amorph. powder;	Unknown.	Cyanide

Ag, Pb, Hg, Cu, Cd, Bi GROUP

	Silver	Lead	Mercury(ous)	Mercury(ic)
Cyanide <i>Cont.</i>	der, or fine, needle cryst.; insol. in wa- ter and dil. acids; decomp. by concd. acids; sol. in KCN + Aq, NH_4OH , $\text{Na}_2\text{S}_2\text{O}_3$ + Aq, $\text{K}_4\text{Fe}(\text{CN})_6$ + Aq, NH_4 salt solns. and in solns. of the chlorides and cy- anides of the alkali and alkaline-earth metals; decomp. when heated at 320° to Ag and $(\text{CN})_2$; sp. gr. 3.9.	in water; sol. in HNO_3 ; decomp. by H_2SO_4 ; sol. in KCN + Aq; par- tially sol. in NH_4OH and in NH_4 salt solns.		ent prisms that darken on expo- sure to light; bit- ter metallic taste; poisonous; moder- ately sol. in cold, more sol. in hot water; sol. in HNO_3 without de- comp.; sol. in KCN + Aq and in alkali chloride solns.; insol. in abs. alcohol; decomp. by hot, concd. H_2SO_4 , by H_2S , Cl_2 , Br_2 and I_2 ; when heated de- comp. to Hg, $(\text{CN})_2$ and paracy- anogen; $\text{Hg}(\text{CN})_2$ forms many dou- ble cyanides with other metals and many double com- pounds with other salts; sp. gr. 4.
Ferro- cyanide	$\text{Ag}_4\text{Fe}(\text{CN})_6$, <i>silver ferrocyanide</i> . White ppt. which turns blue in the air; insol. in wa- ter or dil. acids; insol. in NH_4OH and in NH_4 salt solns.; sol. in KCN + Aq; de- comp. by warm NH_4OH .	$\text{Pb}_2\text{Fe}(\text{CN})_6 \cdot 3\text{H}_2\text{O}$, <i>lead ferrocyanide</i> . White ppt. or yel- lowish white pow- der; insol. in wa- ter, acids and NH_4OH ; sl. sol. in concd. H_2SO_4 , from which it is pptd. by H_2O ; loses all its cryst. water at moderate temp.; the dehydrated salt is decomp. when heated.	$\text{Hg}_4\text{Fe}(\text{CN})_6$, (?) <i>mercury ferrocya- nide, mercurous ferrocyanide</i> . A ppt. of doubtful compn. is obtained when mercurous salts are added to $\text{K}_4\text{Fe}(\text{CN})_6$.	$\text{Hg}_2\text{Fe}(\text{CN})_6$, (?) <i>mercury ferrocya- nide, mercuric ferrocyanide</i> . Blu- ish gray powder of doubtful compn.; insol. in water.
Ferri- cyanide	$\text{Ag}_3[\text{Fe}(\text{CN})_6]$, <i>silver ferricyanide</i> . Orange-yellow powder; insol. in water and in acids; sol. in NH_4OH or $(\text{NH}_4)_2\text{CO}_3$ + Aq.	$\text{Pb}_3[\text{Fe}(\text{CN})_6]$, <i>lead ferri- cyanide</i> . Red- brown powder or small, dark red cryst.; sparingly sol. in cold water, more sol. in hot water, but decomp. on boiling; sol. in acids.	$\text{Hg}_3[\text{Fe}(\text{CN})_6]$, (?) <i>mercury ferri- cyanide, mercurous ferricyanide</i> . Yel- lowish powder of doubtful compn.	$\text{Hg}_3[\text{Fe}(\text{CN})_6]$, (?) <i>mercury ferri- cyanide, mercuric ferricyanide</i> . Yel- lowish powder of doubtful compn.
Fluoride	AgF , <i>silver fluo- ride</i> . Yellow, deli- q., transparent, elastic solid or yel- lowish brown masses; easily sol. in water, 182 g. in 100 g. of water at 16° ; melts at 435° to a sparkling, jet-	PbF_2 , <i>lead fluoride</i> . White, cryst. or amorph. powder; very sl. sol. in wa- ter; somewhat sol. in HCl and in HNO_3 ; decomp. by H_2SO_4 at ordi- nary temp.; melts easily at 855° and	Hg_2F_2 , <i>mercury fluoride, mercur- ous fluoride</i> . Yel- low, cryst. powder or yellow, appar- ently regular cryst. which are massed together; blackens when moist if ex- posed to light;	$\text{HgF}_2 \cdot 2\text{H}_2\text{O}$, <i>mer- cury fluoride, mer- curic fluoride</i> . White, cryst. mass- es; decomp. by cold water, with separation of HgO ; sol. in dil. HNO_3 or HF ; decomp. when heated.

Copper(cuprous)	Copper(cupric)	Cadmium	Bismuth	Cyanide Cont.
powder; insol. in water and dil. acids; sol. in NH_4OH , in NH_4 salt solns., concd. HCl , warm dil. H_2SO_4 and $\text{KCN} + \text{Aq}$; decomp. by HNO_3 ; decomp. at bright red heat; M. P. 474.5° .	ppt.; very unstable; insol. in water; decomp. at ordinary temp. $\text{Cu}(\text{CN})_2$. $\text{Cu}_2(\text{CN})_2$, <i>copper cyanide, cupro-cupric cyanide</i> . Glossy, green cryst. powder or long, transparent, lustrous prisms; insol. in cold water, but decomp. by boiling water; sol. in cold, concd. HCl ; sol. in NH_4OH , $(\text{NH}_4)_2\text{CO}_3 + \text{Aq}$ and in hot NH_4 salt solns.; easily sol. in $\text{KCN} + \text{Aq}$; decomp. at 100° to white $\text{Cu}_3(\text{CN})_2$, H_2O and $(\text{CN})_2$.	sl. sol. in water, 1.7 g. in 100 g. of water at 15° ; easily sol. in acids, sol. in $\text{KCN} + \text{Aq}$, and in warm NH_4OH ; decomp. above 200° in air.		
$\text{Cu}_2\text{Fe}(\text{CN})_6$, (?) <i>copper ferrocyanide, cuprous ferrocyanide</i> . A ppt. of doubtful compn.; insol. in water; sol. in NH_4OH .	$\text{Cu}_2\text{Fe}(\text{CN})_6$, <i>copper ferrocyanide, cupric ferrocyanide, Hattchett's brown, Florentine brown, Vandyke red</i> . Brownish red ppt. or powder; insol. in water or acids; sol. in NH_4OH , $\text{KCN} + \text{Aq}$ and $(\text{NH}_4)_2\text{C}_2\text{O}_4 + \text{Aq}$.	$\text{Cd}_2\text{Fe}(\text{CN})_6$, (?) <i>cadmium ferrocyanide</i> . White powder; insol. in water.	$\text{Bi}_4[\text{Fe}(\text{CN})_6]_3$, <i>bismuth ferrocyanide</i> . Pale, greenish blue ppt. or almost colorless salt; decomp. when moist, giving off HCN and forming Prussian blue; sl. sol. in pure water.	Ferrocyanide
$\text{Cu}_3[\text{Fe}(\text{CN})_6]_2$, <i>copper ferricyanide, cuprous ferricyanide</i> . Brownish red ppt.; sol. in NH_4OH , but not in NH_4 salt solns.	$\text{Cu}_3[\text{Fe}(\text{CN})_6]_2$, <i>copper ferricyanide, cupric ferricyanide</i> . Yellowish powder; insol. in water and in NH_4 salt solns.; sol. in NH_4OH and in $(\text{NH}_4)_2\text{CO}_3 + \text{Aq}$.	$\text{Cd}_3[\text{Fe}(\text{CN})_6]_2$, (?) <i>cadmium ferricyanide</i> . Pale yellow powder of doubtful compn.; insol. in water; sol. in NH_4OH .	$\text{Bi}_3[\text{Fe}(\text{CN})_6]_2$, <i>bismuth ferricyanide</i> . Yellow, amorph. powder or brownish red ppt.; insol. in water; but decomp. by boiling therewith.	Ferricyanide
Cu_2F_2 , <i>copper fluoride, cuprous fluoride</i> . Red ppt. or molten ruby red cryst. masses; insol. in water and in HF ; sol. in concd. HCl to a black liquid, from which it is reprecipitated by water	$\text{CuF}_2 \cdot 2\text{H}_2\text{O}$, <i>copper fluoride, cupric fluoride</i> . Small, transparent, blue cryst. or pale blue, cryst. powder; sl. sol. in cold, decomp. by hot water. CuF_2 , <i>anhydrous</i>	CdF_2 , <i>cadmium fluoride</i> . White powder, cryst. crusts or hard, white, cryst. masses; difficultly sol. in water; easily sol. in HF ; M. P. 1100° ; sp. gr. 6.6.	BiF_3 , <i>bismuth fluoride, bismuth trifluoride</i> . White powder or gray, heavy, cryst. solid; insol. in water or alcohol; sp. gr. 5.3. $\text{BiF}_3 \cdot 3\text{HF}$, <i>acid bismuth fluoride</i> .	Fluoride

Ag, Pb, Hg, Cu, Cd, Bi GROUP

	Silver	Lead	Mercury(ous)	Mercury(ic)
Fluoride <i>Cont.</i>	black liquid; when cooled slowly solidifies to black, hornlike, cryst. masses or to lustrous, somewhat flexible, radiated masses; sp. gr. 5.9.	then solidifies to a yellow mass; sp. gr. 8.2.	partly dissolved and partly decomp. to HF and H ₂ O by water; decomp. by alkalis, with separation of Hg ₂ O; can be heated to c. 260° without decomp.; above this temp. Hg sublimes and the glass vessel is corroded; sp. gr. 8.7; M. P. 570°.	
Hydride	AgH, <i>silver hydride</i> . Said to exist; not decomp. by water.	Unknown.	Unknown.	Unknown.
Hydroxide	<i>Silver hydroxide</i> probably unknown; from silver solns. alkali hydroxides ppt. silver oxide.	3PbO.H ₂ O, <i>lead hydroxide, lead hydrate, hydrated oxide of lead, hydrated lead monoxide</i> . White, cryst. powder consisting of microscopic, transparent, four-sided prisms or regular octahedra; insol. in water; sol. in acids; insol. in NH ₄ OH; sol. in NaOH+Aq or KOH+Aq; sol. in hot NH ₄ Cl+Aq, from which it is reprecipitated by NH ₄ OH; loses some water at 130° and is completely dehydrated at 145°. 2PbO.H ₂ O, <i>hydrated lead monoxide</i> . Beautiful, quadratic cryst. with high luster and strong power of refracting light; sol. in NaOH+Aq and in KOH+Aq. PbO ₂ .H ₂ O, <i>lead perhydroxide, hydrated lead peroxide</i> . Brown ppt.	Hg ₂ (OH) ₂ , <i>mercury hydroxide, mercurous hydroxide, mercury hydrate, mercurous hydrate</i> . Of doubtful existence; the yellow ppt. formed by adding KOH+Aq to Hg ₂ (NO ₃) ₂ +Aq is probably Hg ₂ O, which decomp. easily into HgO and Hg.	Hg(OH) ₂ , <i>mercury hydroxide, mercuric hydroxide, mercury hydrate, mercuric hydrate</i> . Probably does not exist; KOH+Aq ppts. from HgCl ₂ +Aq a yellow ppt., which is probably HgO.

Copper(cuprous)	Copper(cupric)	Cadmium	Bismuth	Fluoride Cont.
as a white powder soon changing to a rose-red; insol. in alcohol; melts at high temp. to a black liquid, which becomes scarlet on cooling; M. P. 908°.	<i>cupric fluoride.</i> White, amorph. powder; takes up water easily, becoming greenish blue; sol. in HCl, HNO ₃ and HF.		Grayish white, deliq. cryst. solid; decomp. by boiling water, forming BiOF. BiOF, <i>bismuth oxyfluoride, bismuthyl fluoride.</i> Heavy, white, cryst. powder; insol. in water; sol. in HCl, HBr and HI.	
CuH , <i>copper hydride, cuprous hydride.</i> Said to exist as a yellow powder which turns brown; insol. in water; sol. in dil. HCl and with decomp. in warm concd. HCl; decomp. at 60° when heated.	CuH₂ , <i>copper hydride, cupric hydride.</i> Said to exist; sol. in HCl with decomp.	Unknown.	Unknown.	Hydride
xCu₂O.yH₂O , <i>copper hydroxide, cuprous hydroxide, copper hydrate, cuprous hydrate, hydrated cuprous oxide.</i> Yellow ppt. that oxidizes in air to cupric hydroxide; sol. in acids to form cupric salts; sol. in NH ₄ OH, but insol. in NaOH+Aq and in KOH+Aq; sol. in (NH ₄) ₂ CO ₃ +Aq; also in Na ₂ S ₂ O ₃ +Aq to a colorless liquid, from which the orange-red Cu ₂ O separates out on heating; dehydrated at 360°.	Cu(OH)₂ , <i>copper hydroxide, cupric hydroxide, copper hydrate, cupric hydrate, hydrated cupric oxide.</i> Greenish blue or light blue, brittle pieces of conchoidal fracture; or fine, blue needles; insol. in H ₂ O, but converted into 3CuO.H ₂ O when boiled therewith; very easily sol. in acids; sol. in NH ₄ OH, in NH ₄ salt solns., cold NaOH+Aq, KOH+Aq, and Na ₂ S ₂ O ₃ +Aq; easily dehydrated when heated. 3CuO.H₂O , <i>hydrated cupric oxide.</i> Black or dark brown, amorph. powder; insol. in water, dil. alkalies and NH ₄ OH; easily sol. in warm NH ₄ Cl+Aq; loses some water at 100°, but is not fully dehydrated even at 300°. CuO₂.H₂O , <i>hydrated copper dioxide,</i>	Cd(OH)₂ , <i>cadmium hydroxide, cadmium hydrate.</i> White, amorph. powder or solid; insol. in water; sol. in acids; very sol. in NH ₄ OH and some NH ₄ salt solns.; insol. in alkali hydroxide solns.; loses its water at 300° and takes up CO ₂ from the air: sp. gr. 4.8.	Bi(OH)₃ , <i>bismuth hydroxide, bismuth trihydroxide, bismuthous hydroxide, bismuth hydrate, bismuth trihydrate.</i> White, flocculent ppt. or white, amorph. powder; insol. in water; sol. in concd. acids. Bi₂O₃.H₂O , <i>bismuth hydroxide, bismuthic hydroxide, hydrated bismuth pentoxide, bismuthic hydrate, bismuthic acid.</i> Beautiful red powder; gives no salts; insol. in water; easily decomp. by acids; slowly but wholly dissolved by hot, concd. HNO ₃ ; decomp. at 120° to Bi ₂ O ₃ , at higher temp. to Bi ₂ O ₄ and then to Bi ₂ O ₅ .	Hydroxide

Ag, Pb, Hg, Cu, Cd, Bi GROUP

	Silver	Lead	Mercury(ous)	Mercury(ic)
Hydroxide <i>Cont.</i>		or blue-black, lustrous solid; insol. in water; sol. in acids and concd. alkali hydroxide solns.; solns. in acids are very unstable, except when concd. and kept at a low temp.; dehydrated at 230° to PbO ₂ .		
Hypo-chlorite	AgOCl , <i>silver hypochlorite</i> . Very sol. in water; decomp. very quickly unless Ag ₂ O is present in the soln.; partly decomp. in the dark; completely decomp. at 60° into AgCl and AgClO ₃ .	Unknown.	Unknown.	Unknown.
Hypo-phosphite	Unknown.	Pb(H₂PO₃)₂ , <i>lead hypophosphite</i> . White, hygroscopic powder, cryst. scales or small rhombic prisms; sl. acid reaction; difficultly sol. in cold, more easily sol. in hot water; insol. in alcohol; decomp. at high temp.	Unknown.	Unknown.
Iodate	AgIO₃ , <i>silver iodate</i> . White powder or small, lustrous, right-angled prisms which seem monoclinic; not completely insol. in water; sol. in NH ₄ OH, HNO ₃ and concd. KI + Aq; decomp. by H ₂ SO ₄ ; melts when heated above 200° with sl. decomp. and on cooling solidifies to a milky-white mass; decomp. at higher temp. to AgI and O ₂ ; sp. gr. 5.5.	Pb(IO₃)₂ , <i>lead iodate</i> . White powder; very, sl. sol. in water; difficultly sol. in HNO ₃ and wholly insol. there-in when heated to 100°; decomp. by concd. HCl; decomp. when heated to 300°.	Hg₂(IO₃)₂ , <i>mercury iodate, mercurous iodate</i> . White powder with mother-of-pearl luster; insol. in boiling water or cold HNO ₃ ; easily sol. in dil. HCl with partial decomp.; decomp. at 250° to HgI ₂ , Hg and O ₂ .	Hg(IO₃)₂ , <i>mercury iodate, mercuric iodate</i> . White, amorph. powder; nearly insol. in water; insol. in alcohol; sparingly sol. in HNO ₃ ; easily sol. in HCl, HBr, HI and solns. of the alkali chlorides, bromides, iodides, cyanides and cyanates; also in Na ₂ S ₂ O ₃ + Aq, dil. MnCl ₂ + Aq and ZnCl ₂ + Aq; insol. in NaOH + Aq, KOH + Aq, NH ₄ OH and in solns. of the alkali

Copper(cuprous)	Copper(cupric)	Cadmium	Bismuth	
	<i>hydrated copper peroxide</i> . Olive-green powder or yellowish brown ppt., which, when moist, is very easily decomp., with evolution of O_2 ; tasteless; neutral reaction; insol. in water; decomp. by acids, with formation of a cupric salt and H_2O_2 ; decomp. at 180° , with formation of CuO and evolution of O_2 .			Hydroxide Cont.
Unknown.	$Cu(OCl)_2$, <i>copper hypochlorite, cupric hypochlorite</i> . Known only in soln. which on standing deposits green cupric oxychloride, $3CuO \cdot CuCl_2 \cdot 4H_2O$.	Unknown.	Unknown.	Hypo-chlorite
Unknown.	$Cu(H_2PO_3)_2$, <i>copper hypophosphite, cupric hypophosphite</i> . Small cryst., very sol. in water, but very easily decomp. on heating, giving Cu_2H_2 .	$Cd(H_2PO_3)_2$, (?) <i>cadmium hypophosphite</i> . Small cryst.; sol. in water; decomp. when heated.	Unknown.	Hypo-phosphite
Unknown.	$Cu(IO_3)_2 \cdot H_2O$, <i>copper iodate, cupric iodate</i> . White or greenish blue powder; or pale blue, voluminous ppt.; sl. sol. in water; sol. in HCl with decomp.; sol. in NH_4OH to dark blue soln.; loses its cryst. water at 240° ; decomp. at higher temp., evolving I_2 and O_2 , and leaving CuO ; sp. gr. 5.2.	$Cd(IO_3)_2$, <i>cadmium iodate</i> . White, cryst. powder; very sl. sol. in water; easily sol. in HNO_3 and NH_4OH ; decomp. when heated to O_2 , I_2 , CdO and CdI_2 ; sp. gr. 6.5.	$Bi(IO_3)_3$, <i>bismuth iodate</i> . Heavy, white powder; insol. in water, H_2SO_4 and in alcohol; sol. in HNO_3 ; easily sol. in HCl ; decomp. when heated.	Iodate

Iodate
Cont.

Iodide

Silver	Lead	Mercury(ous)	Mercury(ic)
			chlorates, bromates and iodates.
AgI, silver iodide, <i>iodyrite</i>, <i>miersite</i>. Hexagonal or quadratic cryst., which, when natural, are lemon-yellow to brownish and translucent, when artificial are brownish yellow to olive-green and highly lustrous; the ppt. is curdy and yellow with an orange tint, or powdery and pale yellow; above ordinary temp. AgI exists in two forms, (1) under 116° it forms brittle, opaque, greenish gray cryst. masses; (2) between 116° and the M. P. 552°, tenacious, translucent, reddish, amorph. masses; odorless and tasteless; unchanged by light if pure; insol. in water or dil. HNO₃; decomp. by hot, concd. HNO₃ or H₂SO₄; easily sol. in concd. HI; sol. in concd. KI+Aq, from which it is reprecipitated by water; sol. in hot Hg(NO₃)₂+Aq, from which it cryst. on cooling; sol. in KCN+Aq; melts at 552° or a low red heat to a yellow, red or reddish brown liquid, which solidifies at 540° to a dirty yellow, brittle, horn-like, opaque mass; sublimes at white heat; sp. gr. 5.7.	PbI₂, lead iodide. Orange-yellow powder or golden-yellow, flexible, six-sided scales or short prisms; dry PbI₂ is unchanged by light; when moist and exposed to direct sunlight, in contact with air, it is slowly changed to PbCO₃, and PbO₂, with separation of I₂; insol. in cold water; slowly but wholly sol. in boiling water, 0.04 g. in 100 g. of water at 0°, 0.07 g. at 25°, 0.4 g. at 100°; insol. in cold, sol. in hot HCl with decomp.; sol. in KOH+Aq; sol. in concd. solns. of the alkali and alkaline earth iodides, from which it is reprecipitated by water; easily sol. in Na₂S₂O₃+Aq; sl. sol. in alcohol; when heated changes color to reddish yellow, then brick-red, and finally to brownish black; melts at 402° to a translucent, reddish brown liquid, which solidifies to a yellow mass; boils between 861° and 954°; sp. gr. 6.2.	Hg₂I₂, mercury iodide, <i>mercurous iodide</i>, <i>green iodide of mercury</i>, <i>yellow iodide of mercury</i>. Green, dark green, or yellowish green powder; yellow, rather large, orthorhombic cryst.; yellow, highly lustrous, tetragonal scales; or yellow, flocculent ppt.; when moist is rapidly blackened by light; very sl. sol. in water or alcohol; sol. in Hg(NO₃)₂+Aq; or KI+Aq; sl. sol. in NH₄OH; sol. in hot NH₄Cl+Aq; decomp. by alkali chlorides+Aq; when heated the yellow cryst. become dark yellow, then orange, and finally garnet-red, but become yellow again on cooling; sublimation begins at c. 190°; softens at 220°; melts at 290° and boils at 310°; decomp. at higher temp.; sp. gr. 7.7.	HgI₂, mercury iodide, <i>mercuric iodide</i>, <i>mercury binioidide</i>, <i>red iodide of mercury</i>, <i>coccinite</i>, <i>iodine red</i>, <i>iodine scarlet</i>, <i>brilliant scarlet</i>, <i>scarlet red</i>, <i>pure scarlet</i>. Obtained by pptn. as a scarlet-colored, heavy, cryst. powder; sl. sol. in water; more sol. in hot alcohol; sol. in many acids especially HCl and HI, but insol. in HC₂H₃O₂; sol. in many NH₄ salt solns., in HgCl₂+Aq, Hg(NO₃)₂+Aq, Na₂S₂O₃+Aq, and in solns. of the sol. iodides. HgI₂ is dimorphous; when heated the red modification which occurs as highly lustrous, tetragonal cryst. or quadratic octahedra, with greenish reflection, changes to the yellow modification; the change occurs at 126°, and is accompanied by a sudden, then regular, expansion; melts at 259° to a blood-red liquid; boils at c. 339° to 359°, and sublimes to yellow, rhombic tablets or scales; the yellow variety passes into the red at the ordinary temp. and the change is hastened by rubbing or scratching; if HgI₂ is allowed to form slowly from its solns. the cryst. appear yellow for a moment, but they quickly change to red; sp. gr. 6.2. HgI₂, <i>mercury peroxide</i>. Orange

Copper(cuprous)	Copper(cupric)	Cadmium	Bismuth
Cu_2I_2, <i>copper iodide, cuprous iodide</i>. White or brownish white, cryst. powder; insol. in water, alcohol and dil. acids; sol. in NH_4OH, $\text{Na}_2\text{S}_2\text{O}_3 + \text{Aq}$, $\text{KCN} + \text{Aq}$ and $\text{KI} + \text{Aq}$; sol. in an alcoholic soln. of I_2; sol. in hot, concd. HCl, but reppts. on adding water; decomp. by concd. HNO_3 or H_2SO_4; also by alkalies and alkali carbonates; melts at 605°, and then solidifies to a brown mass, which can be pulverized to a greenish powder; boils at 759° to 772°; sp. gr. 5.6.	CuI_2, <i>copper iodide, cupric iodide</i>. Known only in soln.; has not been isolated; immediately breaks up into Cu_2I_2 and I_2.	CdI_2, <i>cadmium iodide</i>. Large, transparent, six-sided tablets with metallic luster; stable in air; sol. in water, 80 g. in 100 g. of water at 0°, 86 g. at 20°, 127 g. at 100°; sol. in alcohol and warm NH_4OH; melts easily at 383°; boils at 708° to 719°; sp. gr. 5.7.	BiI_3, <i>bismuth iodide, bismuth triiodide</i>. Black or brownish gray, lustrous scales or six-sided tablets; fine, green, glistening cryst. with metallic luster; or brown, cryst. ppt.; not attacked by cold, but decomp. by boiling water, with formation of BiOI; somewhat sol. in alcohol; sol. in HNO_3 or HI, from which it is repptd. by water or alcohol; sol. in $\text{KOH} + \text{Aq}$ or $\text{KI} + \text{Aq}$; M. P. 439°; forms a reddish brown vapor at a higher temp. BiOI, <i>bismuth oxyiodide, bismuth subiodide, bismuthyl iodide</i>. Beautiful red or brownish red, odorless, tasteless powder; insol. in water; sol. in HCl; decomp. by HNO_3.

Iodate
Cont.

Iodide

Ag, Pb, Hg, Cu, Cd, Bi GROUP

Iodide
Cont.

Manganate

Molybdate

Nitrate

Silver	Lead	Mercury(ous)	Mercury(ic)
			powder, brown, cryst. ppt. or large, rhombic cryst., which are contaminated with a little HgI_2 ; sol. in $\text{KI}+\text{Aq}$; quickly decomp. by alcohol, slowly by water with formation of red HgI_2 .
Unknown.	$\text{PbMnO}_4 \cdot 2\text{H}_2\text{O}$, <i>lead manganate</i> . Chocolate-brown amorph. powder; insol. in water.	Unknown.	Unknown.
AgMnO_4 , <i>silver permanganate</i> . Dark violet monoclinic cryst.; easily decomp.; somewhat sol. in cold water, more in hot; soln. decomp. when boiled.	$\text{Pb}(\text{MnO}_4)_2$, <i>lead permanganate</i> . Known only in soln.; sol. in HNO_3 .	Unknown.	$\text{Hg}(\text{MnO}_4)_2$, <i>mercury permanganate, mercuric permanganate</i> . Very unstable; has not been obtained free.
Ag_2MoO_4 , <i>silver molybdate</i> . Yellow amorph. powder; melts to a yellow liquid when heated; insol. in water; sol. in HNO_3 , $\text{NaOH}+\text{Aq}$ or $\text{KCN}+\text{Aq}$.	PbMoO_4 , <i>lead molybdate, wulfenite</i> . White or yellow powder or tablets; insol. in water or $\text{H}_2\text{C}_2\text{O}_4$; sol. in HNO_3 or $\text{NaOH}+\text{Aq}$, when moist, but not after heating; sol. in concd. HCl ; decomp. by H_2SO_4 .	Hg_2MoO_4 , <i>mercury molybdate, mercurous molybdate</i> . Flocculent ppt. that becomes cryst. on standing; insol. in water.	Unknown.
AgNO_3 , <i>silver nitrate, lunar caustic, silver saltpeter</i> . Colorless, or whitish, odorless, rhombic, trimetric plates; bitter, caustic, metallic taste; not hygroscopic; stable in pure dry air; blackens in air, if organic matter is present; rapidly reduced to Ag by organic matter in the light; sol. in water to a neutral solution, 122 g. in 100 g. of water at 0° , 222 g. at 20° , 952 g. at 100° ; sol. in alcohol; M. P. 212° ; decomp. at low red heat to Ag, O_2 , N_2 and NO_2 ; sp. gr. 4.3.	$\text{Pb}(\text{NO}_3)_2$, <i>lead nitrate, normal lead nitrate</i> . Hard, lustrous, milk-white, semi-cryst. lumps; or colorless to white, regular octahedra, or monoclinic cryst.; stable in air; sol. in water, with absorption of much heat, 39 g. in 100 g. of water at 0° , 56 g. at 20° , 138 g. at 100° ; sl. sol. in alcohol; insol. in concd. HNO_3 ; decomp. at low red heat to PbO , O_2 , and NO_2 ; M. P. 470° ; sp. gr. 4.5.	$\text{Hg}_2(\text{NO}_3)_2 \cdot 2\text{H}_2\text{O}$, <i>mercury nitrate, mercurous nitrate, normal mercurous nitrate</i> . Short, colorless prisms, or monoclinic tablets; or striated hexagonal prisms; sl. efflor.; sol. in a little water; decomp. by much water to an insol. basic nitrate; sol. in very dil. HNO_3 ; melts easily at 70° ; sp. gr. 4.8.	$2\text{Hg}(\text{NO}_3)_2 \cdot \text{H}_2\text{O}$, <i>mercury nitrate, mercuric nitrate, normal mercuric nitrate</i> . White, deliq. powder; sharp, metallic taste; very sol. in a little water; dilution ppts. an insol. basic nitrate; insol. in alcohol; decomp. by heat to a basic nitrate; M. P. 79° ; sp. gr. 4.3. $\text{Hg}(\text{NO}_3)_2 \cdot 8\text{H}_2\text{O}$, <i>mercuric nitrate</i> . Long, clear, colorless, rhombic tablets; sol. in water; melts at 6° in its cryst. water.

Ag, Pb, Hg, Cu, Cd, Bi GROUP

Copper(cuprous)	Copper(cupric)	Cadmium	Bismuth	Iodide Cont.
Unknown.	Unknown.	Unknown.	Unknown.	Manganate
Unknown.	$\text{Cu}(\text{MnO}_4)_2 \cdot 8\text{H}_2\text{O}$, <i>copper permanganate, cupric permanganate. Deliq. masses.</i>	$\text{Cd}(\text{MnO}_4)_2 \cdot 7\text{H}_2\text{O}$, <i>cadmium permanganate. Fairly stable masses.</i>	$\text{Bi}(\text{MnO}_4)_3$, <i>bismuth permanganate. Black, bulky powder; sol. in dil. acids.</i>	
Unknown.	CuMoO_4 , (?) <i>cupper molybdate, cupric molybdate. Heavy, green, amorph. powder; sl. sol. in water; decomp. by acids and alkaline solns.</i>	CdMoO_4 , <i>cadmium molybdate. Heavy, granular powder, or yellow leaflets; insol. in water; sol. in acids, NH_4OH, or $\text{KCN} + \text{Aq.}$</i>	$\text{Bi}_2(\text{MoO}_4)_3$, <i>bismuth molybdate. Yellow powder; somewhat sol. in water and in the stronger acids.</i>	Molybdate
Unknown.	$\text{Cu}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$, <i>copper nitrate, cupric nitrate, normal cupric nitrate. Blue tabular cryst.; efflor. in air, losing $3\text{H}_2\text{O}$; sol. in water; melts in its cryst. water at 26°; decomp. at 65°; forming a basic salt. $\text{Cu}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O}$, <i>cupric nitrate. Blue, deliq., prismatic cryst.; very easily sol. in water or alcohol; the aq. soln. is green when concd., but pale blue when dil.; sol. in moderately concd. HNO_3; melts in its cryst. water at 114.5°; decomp. at 170°; sp. gr. 2.</i></i>	$\text{Cd}(\text{NO}_3)_2$, <i>cadmium nitrate, normal cadmium nitrate. White, prismatic, deliq. needles, or white, amorph. masses; very sol. in water, 110 g. in 100 g. of water at 0°, 127 g. at 18°, 327 g. at 60°; sol. in alcohol; nearly insol. in concd. HNO_3; melts at 59° in its cryst. water; B. P. c. 132°; decomp. by HCl; the anhydrous salt melts at 350°; sp. gr. 2.4.</i>	$\text{Bi}(\text{NO}_3)_3 \cdot 5\text{H}_2\text{O}$, <i>bismuth nitrate, normal bismuth nitrate. Large, lustrous, clear, colorless, deliq., very caustic cryst.; acid taste; decomp. by a little water, with separation of a basic nitrate; sol. in dil. HNO_3; but reprecipitated therefrom by dilution with water; melts easily in its cryst. water; decomp. at 30°, with formation of basic salts; decomp. by HCl, giving BiCl_3; sp. gr. 2.8.</i>	Nitrate

Ag, Pb, Hg, Cu, Cd, Bi GROUP

Nitrate
Cont.

Silver	Lead	Mercury(ous)	Mercury(ic)
Unknown.	$xPbO.yN_2O_5.zH_2O$, <i>basic lead nitrate</i> . Several are known; generally white powders and sl. sol. in cold, more in hot water.	$xHg_2O.yN_2O_5.zH_2O$, <i>basic mercurous nitrate</i> . Several are known; generally yellowish white powders or colorless cryst.; insol. in water; sol. in HNO_3 .	$xHgO.yN_2O_5.zH_2O$, <i>basic mercuric nitrate</i> . Several are known; generally white cryst. powders; insol. in water.
Nitrite	$Pb(NO_2)_2 \cdot H_2O$, <i>lead nitrite, normal lead nitrite</i> . Yellow leaflets or needles; decomp. easily; very sol. in water.	$HgNO_2$, (?) <i>mercury nitrite, mercurous nitrite</i> . Not definitely known; decomp. at 140° ; sp. gr. 5.9.	$Hg(NO_2)_2$, <i>mercury nitrite, mercuric nitrite</i> . Known only in soln. as a double salt with KNO_3 .
	$xPbO.yN_2O_5.zH_2O$, <i>basic lead nitrite</i> . Several are said to exist; generally white powders; sl. sol. in water; sol. in HNO_3 .	Unknown.	$Hg(NO_2)_2 \cdot 2HgO \cdot H_2O$, <i>basic mercuric nitrite</i> . Amorph. powder.
Oxalate	$Ag_2C_2O_4$, <i>silver oxalate</i> . White cryst. powder; insol. in water; sol.	PbC_2O_4 , <i>lead oxalate</i> . Heavy, white powder; insol. in water; sol. in HNO_3 .	$Hg_2C_2O_4$, <i>mercury oxalate, mercurous oxalate</i> . White to grayish white,
			HgC_2O_4 , <i>mercury oxalate, mercuric oxalate</i> . White to grayish white,

Copper(cuprous)	Copper(cupric)	Cadmium	Bismuth	Nitrate Cont.
Unknown.	$\text{Cu}(\text{NO}_3)_2$, <i>anhydrous cupric nitrate, gerhardite</i>. White, deliq. powder; easily sol. in water, 45 g. in 100 g. of soln. at 0°, 55 g. at 20°, 67 g. at 80°, but reprecipitated by concd. HNO_3; decomp. at red heat, evolving N oxides and leaving CuO; decomp. by HCl. $4\text{CuO} \cdot \text{N}_2\text{O}_5 \cdot 3\text{H}_2\text{O}$, <i>basic cupric nitrate</i>. Green powder or greenish blue leaflets; insol. in water; easily sol. in acids; decomp. at high temp.	$2\text{CdO} \cdot \text{N}_2\text{O}_5 \cdot 3\text{H}_2\text{O}$, <i>basic cadmium nitrate</i>. White, amorph. powder; insol. in water.	$x\text{Bi}_2\text{O}_3 \cdot y\text{N}_2\text{O}_5 \cdot z\text{H}_2\text{O}$, <i>basic bismuth nitrate, bismuth subnitrate, bismuth white, magister of bismuth, paint white, pearl white, Spanish white, bismuth magister</i>. White, amorph. or cryst. powder of compn. that varies with the temp. and the amount of acid present; insol. in water; sol. in HNO_3.	
Unknown.	$\text{Cu}(\text{NO}_2)_2$, (?) <i>copper nitrite, cupric nitrite</i>. Fine, green powder of variable compn. and very unstable; generally found only in aq. soln.	$\text{Cd}(\text{NO}_2)_2 \cdot \text{H}_2\text{O}$, <i>cadmium nitrite</i>. Yellow, deliq. cryst. masses; sol. in water.	Unknown.	Nitrite
Unknown.	$4\text{CuO} \cdot \text{N}_2\text{O}_5 \cdot 3\text{H}_2\text{O}$, <i>basic cupric nitrite</i>. Feathery groups of needle cryst.; stable in air; decomp. when boiled with water; very sl. sol. in water or alcohol; easily sol. in NH_4OH or dil. acids.	$2\text{CdO} \cdot \text{N}_2\text{O}_5$, <i>basic cadmium nitrite</i>. White, amorph. powder; insol. in water.	Unknown.	
Unknown.	$2\text{CuC}_2\text{O}_4 \cdot \text{H}_2\text{O}$, <i>copper oxalate, cupric oxalate</i>. Green, amorph. powder;	$\text{CdC}_2\text{O}_4 \cdot 3\text{H}_2\text{O}$, <i>cadmium oxalate</i>. Fine, white, cryst. powder; very	$2\text{Bi}_2(\text{C}_2\text{O}_4)_3 \cdot 15\text{H}_2\text{O}$, <i>bismuth oxalate</i>. White, granular powder; insol. in	Oxalate

	Silver	Lead	Mercury(ous)	Mercury(ic)
Oxalate <i>Cont.</i>	in HNO_3 ; detonates when heated dry.		amorph. powder; insol. in water; sol. in HNO_3 .	amorph. powder; insol. in water; sol. in HCl ; explodes violently on concussion.
Oxide	Ag_2O, <i>silver oxide, silver suboxide, argentous oxide</i>. Of doubtful existence; a gray or black powder; insol. in water; decomp. by acids; is probably a mixture of finely divided Ag with Ag_2O. Ag_2O, <i>silver oxide, argentic oxide</i>. Heavy, brownish, or bluish black, amorph. powder; or brownish ppt.; odorless; disagreeable, metallic taste; sl. sol. in water when freshly made, the soln. turning red litmus paper blue; sol. in acids, NH_4OH, or $(\text{NH}_4)_2\text{CO}_3 + \text{Aq}$; decomp. into Ag and O_2 when heated to 300°; sp. gr. 7.1. Ag_2O_2, <i>silver oxide, silver peroxide</i>. Small, black, lustrous octahedra, or prisms that are composed of octahedra; insol. in water; sol. in NH_4OH, HNO_3, or concd. H_2SO_4 without decomp.; at c. 110° it decomp., evolving O_2; sp. gr. 7.4.	Pb_2O, <i>lead oxide, lead suboxide</i>. Black, lustrous powder; decomp. by water to $\text{PbO} \cdot x\text{H}_2\text{O}$; decomp. by dil. HCl, H_2SO_4, HNO_3, $\text{HC}_2\text{H}_3\text{O}_2$ or alkalis, into PbO, which dissolves and Pb, which dissolves or not, according to the reagent; sol. in dil. $\text{Pb}(\text{NO}_3)_2 + \text{Aq}$; burns to PbO when heated in air. PbO, <i>lead oxide, lead monoxide, plumbous oxide, litharge, massicot, massicotite</i>. Generally yellow to reddish yellow, heavy, amorph. or finely cryst. powder; sometimes sulfur-yellow, rhombic octahedra, or dark red tetragonal cryst.; nearly insol. in water; easily sol. in acids; sol. in $\text{Pb}(\text{C}_2\text{H}_3\text{O}_2)_2 + \text{Aq}$, or in hot $\text{KOH} + \text{Aq}$ or $\text{NaOH} + \text{Aq}$; oxidizes to Pb_2O_4 at 300° to 450°, but is deoxidized to PbO at higher temp.; melts at 888° to a clear dark red liquid; sp. gr. 8. to 9.5. Pb_2O_3, <i>lead oxide, lead sesquioxide, plumbic oxide, plumbic oxide</i>. Reddish yellow or greenish brown powder; insol. in water or $\text{KOH} + \text{Aq}$; decomp. by concd. acids into PbO_2 and the corresponding salt of PbO; gives off O_2.	Hg_2O, <i>mercury oxide, mercurous oxide, mercury suboxide, black oxide of mercury</i>. Black powder or masses; insol. in water, dil. HCl, HNO_3, $\text{KOH} + \text{Aq}$, $\text{NaOH} + \text{Aq}$, and alcohol; sol. in warm, concd. $\text{HC}_2\text{H}_3\text{O}_2$; with warm, dil. acids Hg_2O generally yields mercurous salts; very easily decomp. by light or heat, giving HgO and Hg; gives Hg and O_2 when strongly heated.	HgO, <i>mercury oxide, mercuric oxide, montroyite, calcined mercury, red oxide of mercury, red precipitate, or yellow oxide of mercury, yellow precipitate</i> according to the color. Heavy, dull, orange-red, amorph. powder, or red, cryst. scales; occasionally yellow, bulky amorph. powder; metallic taste; violent poison; insol. in water, $\text{KOH} + \text{Aq}$, $\text{NaOH} + \text{Aq}$ and alcohol; sol. in most acids, forming mercuric salts; decomp. at red heat into Hg and O_2; heated below the temp. of decomp. it turns black, but returns to its original color on cooling; slowly blackened and decomp. to Hg and O_2 on standing by the action of light; sp. gr. 11.1.

Copper(cuprous)	Copper(cupric)	Cadmium	Bismuth	Oxalate Cont.
	insol. in water; sol. in acids.	nearly insol. in water; sol. in acids.	water; sol. in acids.	
Cu₂O , <i>copper oxide, copper suboxide</i> . Olive-green, amorph. powder; stable under water, in absence of O ₂ ; rapidly oxidized in air to Cu ₂ O, and then to CuO; not attacked by water or NH ₄ OH; decomp. by dil. HCl to Cu ₂ Cl ₂ and Cu, by dil. H ₂ SO ₄ to CuSO ₄ and Cu. Cu₂O , <i>copper oxide, cuprous oxide, red oxide of copper, cuprite, red copper oxide, red copper ore, flowers of copper, ruby copper, hemioxide of copper</i> . Dark-red or carmine-red cryst. or granular powder; native as lustrous, red octahedra; insol. in water; sol. in NH ₄ OH to a colorless soln., which turns blue in air, and reacts as a strong, reducing agent; sl. sol. in boiling KOH + Aq; sol. in HCl, forming Cu ₂ Cl ₂ ; dil. H ₂ SO ₄ , HNO ₃ , and HC ₂ H ₃ O ₂ produce Cu and cupric salts; concd. HNO ₃ forms Cu(NO ₃) ₂ only; melts at red heat; sp. gr. 6.	CuO , <i>copper oxide, cupric oxide, black oxide of copper, copper monoxide, melaconite, tenorite, paramelaconite, flowers of copper</i> . Brownish-black, amorph. powder; metal-like, lustrous, monoclinic cryst.; or coarse, black granules; insol. in water or NH ₄ OH; insol. in dil. but sol. in warm concd. NaOH + Aq or KOH + Aq; easily sol. in acids, with formation of cupric salts; melts at very high temp.; easily reduced to Cu by H ₂ , CO, C or C compounds; sp. gr. 6.4. CuO₂ , <i>copper oxide, copper dioxide, copper peroxide</i> . Generally found as CuO ₂ . H ₂ O; a yellowish-brown amorph. ppt.; tasteless; neutral reaction; decomp. very easily, evolving O ₂ ; when moist it decomp. at 6°, when dry it decomp. at 108°, leaving CuO; insol. in water; sol. in acids, forming cupric salts and H ₂ O ₂ or O ₂ . Other oxides of Cu are said to exist, but they are probably mixtures of the preceding oxides.	Cd₂O , <i>cadmium oxide, cadmium suboxide, cadmous oxide</i> . Green powder of doubtful existence; decomp. when heated. CdO , <i>cadmium oxide, cadmium monoxide, cadmic oxide</i> . Dark brown, amorph., infusible powder; or blackish brown or dark red, very small, octahedral cryst.; insol. in water, KOH + Aq or NaOH + Aq; sol. in NH ₄ OH or acids; easily sol. in NH ₄ Cl + Aq; sp. gr. 8.1. Other oxides of Cd are said to exist.	Bi₂O₃ , <i>bismuth oxide, bismuth dioxide, bismuth suboxide, hypobismuthous oxide, black oxide of bismuth</i> . Brownish gray, blackish gray, dark, purple-brown, or black, fine, cryst. powder; insol. in water, but oxidizes easily in the air when moist to Bi ₂ O ₃ ; sol. in concd. HNO ₃ ; decomp. by dil. HNO ₃ , by strong acids, and by boiling KOH + Aq; begins to oxidize in air at c. 180°; oxidizes quickly at red heat to Bi ₂ O ₃ ; sp. gr. 7.5. Bi₂O₅ , <i>bismuth oxide, bismuth trioxide, bismuthous oxide, bismuth yellow, bismon, bismuth ochre, bismite</i> . Heavy, pale lemon-yellow powder, or small, yellow, lustrous needles; unchanged in air or O ₂ ; insol. in water; sol. in concd. acids; changes to red-brown at high temp., but becomes yellow when cooled; melts at strong red heat, solidifying to a cryst. mass on cooling; vaporizes only at extremely high temp.; sp. gr. 5.6. Bi₂O₄ , <i>bismuth oxide, bismuth tetroxide, hypobismuthic oxide</i> . Heavy, brownish yellow solid or powder; insol. in water; sol. in	

Ag, Pb, Hg, Cu, Cd, Bi GROUP

Oxide
Cont.

Silver	Lead	Mercury(ous)	Mercury(ic)
	at c. 370°, leaving Pb_3O_4; at c. 530° PbO is left. Pb_3O_4, sometimes written $2PbO \cdot PbO_2$, <i>lead oxide, diplumbo-plumbic oxide, red lead, minium, crystal minium, lead tetroxide, mineral orange, mineral lead, mineral red, sandix, saturn red, Paris red, red lead oxide</i>. Bright red, heavy, amorph. or finely cryst. powder; insol. in water; dil. acids convert it to corresponding salts of PbO, with separation of insol. PbO_2; hot, concd. H_2SO_4 forms $PbSO_4$ and O_2; sol. in concd. H_3PO_4 and in excess of glacial $HC_2H_3O_2$; when heated in air it becomes brighter red, then violet; decomp. at 500° to 530° to PbO and O_2; sp. gr. 9.1. PbO_2, <i>lead oxide, plumbic oxide, lead dioxide, lead peroxide, brown oxide of lead, plumbic acid, puce, brown lead oxide, plattnerite</i>. Dark puce-brown or black powder; when native, it forms metal-like, lustrous, iron-black, hexagonal cryst.; when heated it gives Pb_3O_4 and O_2 easily; at higher temp. PbO and O_2; gives up one-half its oxygen readily to easily oxidized bodies, either at ordinary temperature or by sl. heating; when rubbed with P or S violent combustion occurs; when rubbed with organic substances, like sugar or tartaric acid, it oxidizes these rapidly, causing ignition; insol. in water; sol. in concd. $KOH + Aq$ or $NaOH + Aq$, decomp. by NH_4OH; insol. in moderately concd. HNO_3, H_2SO_4 or $HC_2H_3O_2$; hot, concd. H_2SO_4 gives $PbSO_4$ and O_2; cold, concd. HCl in excess dissolves PbO_2, producing a yellow liquid, which probably contains $PbCl_4$ when cold, but evolves Cl_2 when heated, and ppts. $PbCl_2$; hot HCl forms Cl_2 and $PbCl_2$ directly; PbO_2 reacts as an acid oxide, with strongly basic oxides to form plumbates; sp. gr. 9.4.		
Phosphate Ag_3PO_4, <i>silver phosphate, normal silver phosphate, neutral silver phosphate, trisilver orthophosphate, tertiary silver phosphate</i>. Yellow powder, or clear, yellow cryst.; insol. in water or $Na_2HPO_4 + Aq$; sol. in HNO_3, H_3PO_4, $HC_2H_3O_2$, NH_4OH or $(NH_4)_2CO_3 + Aq$; darkened by light; turns red-brown when heated; melts at red heat to a dark brown liquid, that turns yellow on cooling. Ag_2HPO_4, <i>silver phosphate, acid silver phosphate, disilver orthophosphate, secondary silver phosphate</i>. White, cryst. leaflets, hexagonal cryst., or cryst.	$Pb_3(PO_4)_2$, <i>lead phosphate, normal lead phosphate, neutral lead phosphate, trilead orthophosphate, tertiary lead phosphate</i>. White powder; insol. in water or $HC_2H_3O_2$; sol. in $KOH + Aq$ or HNO_3. $PbHPO_4$, <i>lead phosphate, acid lead phosphate, dilead orthophosphate, secondary lead phosphate</i>. White, lustrous, cryst. powder, consisting of micro-	Hg_2PO_4, <i>mercury phosphate, mercurous phosphate, normal mercurous phosphate, neutral mercurous phosphate, trimercurous orthophosphate, tertiary mercurous phosphate</i>. White, amorph. powder; decomp. by boiling with water; sol. in HNO_3 or $Hg_2(NO_3)_2 + Aq$; insol. in H_3PO_4; decomp. by heat to mercuric phosphate. Secondary mercurous phosphate unknown.	$Hg_2(PO_4)_2$, <i>mercury phosphate, mercuric phosphate, normal mercuric phosphate, neutral mercuric phosphate, trimercuric orthophosphate, tertiary mercuric phosphate</i>. White, cryst. powder; or small, lustrous needle cryst.; insol. in cold, sl. sol. in hot water; insol. in alcohol; easily sol. in HNO_3; slowly sol. in cold dil., quickly in hot dil. or cold concd. HCl; melts to a dark yellow liquid when heated. Secondary mercuric phosphate unknown.

Ag, Pb, Hg, Cu, Cd, Bi GROUP

Copper(cuprous)	Copper(cupric)	Cadmium	Bismuth	Oxide Cont.
			concd. HCl, with evolution of Cl₂; sol. in oxygen acids, with evolution of O₂; less easily sol. in concd. H₂SO₄ than in HNO₃. Bi₂O₃, <i>bismuth oxide, bismuth pentoxide, bismuth peroxide, bismuthic oxide.</i> Heavy, dark brown, or red powder; sol. in dil. acids; evolves O₂ at 150°; changes to Bi₂O₄ at 225° and to Bi₂O₅ at still higher temp.; combines with water to form bismuthic hydroxide.	
Tertiary cuprous phosphate unknown.	Cu₃(PO₄)₂·3H₂O, <i>copper phosphate, cupric phosphate, normal cupric phosphate, neutral cupric phosphate, tricupric orthophosphate, tertiary cupric phosphate.</i> Blue green or beautiful blue cryst. powder; insol. in water; sol. in NH₄OH; easily sol. in acids, even H₃PO₄, HC₂H₃O₂, or H₂SO₃; turns brown when heated, with loss of cryst. water.	Cd₃(PO₄)₂, <i>cadmium phosphate, normal cadmium phosphate, neutral cadmium phosphate, tricadmium orthophosphate, tertiary cadmium phosphate.</i> Amorph. ppt.; insol. in water; sol. in Cd salt solns. and in NH₄ salt solns.	BiPO₄, <i>bismuth phosphate, normal bismuth phosphate, neutral bismuth phosphate, tribismuth orthophosphate, tertiary bismuth phosphate.</i> White ppt.; insol. in water or HNO₃; more sol. in HCl; sol. in NH₄Cl + Aq.	Phosphate
Secondary cuprous phosphate unknown.	CuHPO₄, <i>copper phosphate, acid cupric phosphate, dicupric orthophosphate, secondary cupric phosphate.</i> Amorph. powder of doubtful	CdHPO₄, <i>cadmium phosphate, acid cadmium phosphate, dicadmium orthophosphate, secondary cadmium phosphate.</i> White powder; insol. in water;	Secondary bismuth phosphate unknown.	

Ag, Pb, Hg, Cu, Cd, Bi GROUP

Phosphate
Cont.

Silver	Lead	Mercury(ous)	Mercury(ic)
powder; decomp. by water to H_3PO_4 and Ag_3PO_4 ; sol. in H_2PO_4 .	scopic leaflets; insol. in water or $HC_2H_3O_2$; sol. in HNO_3 , $NaOH$ + Aq or KOH + Aq; sol. in NH_4Cl + Aq, but repptd. therefrom by NH_4OH ; decomp. by H_2SO_4 or HCl ; decomp. by heat.		
Primary silver phosphate unknown.	Primary lead phosphate unknown	Primary mercurous phosphate unknown.	Primary mercuric phosphate unknown.
$\Delta Ag_2(PO_3)_2$, silver metaphosphate, disilver metaphosphate. Cryst. powder; insol. in water; melts at low red heat to a clear liquid.	$Pb(PO_3)_2$, lead metaphosphate, dilead metaphosphate. Small cryst. or amorph. powder; insol. in water; sol. in HNO_3 ; melts at red heat and cools to a transparent, glass-like solid.	$(Hg_2)_3(PO_3)_6$, mercurous metaphosphate, hexamercurous metaphosphate. White powder; insol. in water; very sl. sol. in acids.	$Hg_3(PO_3)_6$, mercuric metaphosphate, hexamercuric metaphosphate. White powder; sl. sol. in water when freshly pptd.; more sol. in acids than the mercurous salt.
$Ag_4P_2O_7$, silver pyrophosphate. White powder; insol. in cold or hot water, $Na_4P_2O_7$ + Aq or $HC_2H_3O_2$; sol. in NH_4OH or cold HNO_3 without decomp.; hot HNO_3 or H_2SO_4 decomp. it to silver orthophosphate; decomp. by HCl to $AgCl$ and H_3PO_4 ; turns red in the air; melts at a red heat to a dark brown liquid, which cools to a white, cryst. mass.	$Pb_2P_2O_7$, lead pyrophosphate. White, amorph. powder, or colorless, transparent, rhombic prisms; insol. in cold water, but decomp. when boiled; insol. in NH_4OH or $HC_2H_3O_2$; sol. in HNO_3 , $Na_4P_2O_7$ + Aq or KOH + Aq.	$Hg_2P_2O_7 \cdot H_2O$, mercurous pyrophosphate. Heavy, white powder; insol. in water; decomp. by HCl ; sol. in HNO_3 ; insol. in $Na_4P_2O_7$ + Aq, when heated to 100° .	$Hg_2P_2O_7$, mercuric pyrophosphate. White ppt. that turns yellowish red; insol. in water; sol. in acids; insol. in $Na_4P_2O_7$ + Aq; decomp. by $NaOH$ + Aq or KOH + Aq.
Unknown.	$PbHPO_3$, lead phosphite, normal lead phosphite. Loose, white powder; insol. in water; very sl. sol. in H_3PO_3 + Aq; easily sol. in cold HNO_3 ; reduces H_2SO_4 to SO_2 ; decomp. by heat.	Unknown.	$HgHPO_3$, (?) mercury phosphite, mercuric phosphite. White powder; decomp. by heat, leaving some metallic Hg.
	$PbH_2(HPO_3)_2$,		

Phosphite

Ag, Pb, Hg, Cu, Cd, Bi GROUP

Copper(cuprous)	Copper(cupric)	Cadmium	Bismuth
	compn.; insol. in water, or $\text{NH}_4\text{Cl} + \text{Aq}$; sol. in H_3PO_4 or $\text{HC}_2\text{H}_3\text{O}_2$.	melts to a transparent, glass-like solid at white heat.	
Primary cuprous phosphate unknown.	Primary cupric phosphate unknown.	$\text{Cd}(\text{H}_2\text{PO}_4)_2$, <i>cadmium phosphate, acid cadmium phosphate, monocadmium orthophosphate, primary cadmium phosphate</i> . Gelatinous masses; decomp. by large excess of water.	Primary bismuth phosphate unknown.
Cuprous metaphosphate unknown.	$\text{Cu}(\text{PO}_3)_2$, <i>cupric metaphosphate, dicupric metaphosphate</i> . Bluish white powder; insol. in water; sol. in most concd. acids; also in alkalis, except NH_4OH .	$\text{Cd}(\text{PO}_3)_2$, <i>cadmium metaphosphate, dicadmium metaphosphate</i> . White ppt.; insol. in water.	$\text{Bi}(\text{PO}_3)_3$, <i>bismuth metaphosphate</i> . White powder; insol. in water or NH_4OH .
Cuprous pyrophosphate unknown.	$\text{Cu}_2\text{P}_2\text{O}_7$, <i>cupric pyrophosphate</i> . Greenish white, amorph. powder that becomes cryst. when boiled in $\text{SO}_2 + \text{Aq}$; turns blue when heated dry to 100° ; insol. in water; sol. in NH_4OH and mineral acids; sometimes cryst. with $2\text{H}_2\text{O}$.	$\text{Cd}_2\text{P}_2\text{O}_7 \cdot 2\text{H}_2\text{O}$, <i>cadmium pyrophosphate</i> . White powder; insol. in water or $\text{KOH} + \text{Aq}$; sol. in NH_4OH , $\text{Na}_4\text{P}_2\text{O}_7 + \text{Aq}$ or acids.	$\text{Bi}_4(\text{P}_2\text{O}_7)_3$, <i>bismuth pyrophosphate</i> . White ppt.; insol. in water or HNO_3 ; sol. in $\text{Na}_4\text{P}_2\text{O}_7 + \text{Aq}$.
Unknown.	$\text{CuHPO}_3 \cdot 2\text{H}_2\text{O}$, <i>copper phosphite, cupric phosphite</i> . Bluish white, flocculent ppt. or cryst. powder; insol. in water.	$\text{CdHPO}_3 \cdot 3\text{H}_2\text{O}$, <i>cadmium phosphite</i> . White powder; loses some cryst. water at c. 200° ; decomp. at higher temp., leaving some metallic Cd.	$\text{Bi}(\text{HPO}_3)_3$, <i>bismuth phosphite</i> . White ppt.; decomp. when heated, sometimes evolving H_2 .

Phosphate
Cont.

Phosphite

Ag, Pb, Hg, Cu, Cd, Bi GROUP

	Silver	Lead	Mercury(ous)	Mercury(ic)
Phosphite Cont.		<i>acid lead phosphite.</i> Beautiful cryst.; decomp. by water to PbHPO_3 and H_3PO_3 . $\text{xPbO.yP}_2\text{O}_3.\text{zH}_2\text{O}$, <i>basic lead phosphite.</i> White powder; insol. in water; sol. in warm, dil. $\text{H}_3\text{PO}_3 + \text{Aq.}$		
Silicate	Ag_2SiO_3 , <i>silver silicate, silver metasilicate.</i> Yellow masses or powder; insol. in water; sol. in NH_4OH ; decomp. by acids.	PbSiO_3 , (?) <i>lead silicate, lead metasilicate, alamosite.</i> White, cryst. powder or glass-like solid; insol. in water; decomp. by acids.	Hg_2SiO_3 , (?) <i>mercury silicate, mercurous silicate, mercurous metasilicate.</i> White powder of doubtful compn.; insol. in water.	Unknown.
Silico-fluoride	$\text{Ag}_2\text{SiF}_6.4\text{H}_2\text{O}$, <i>silver silicofluoride, silver fluosilicate.</i> White, deliq. octahedral cryst. or cryst. powder; easily sol. in water; melts below 100° ; loses its cryst. water with further decomp. at higher temp.	$\text{PbSiF}_6.2\text{H}_2\text{O}$, <i>lead silicofluoride, lead fluosilicate.</i> Monoclinic prisms, or transparent, gelatinous masses; deliq.; easily sol. in water. $\text{PbSiF}_6.4\text{H}_2\text{O}$, <i>lead silicofluoride.</i> Fairly large, monoclinic cryst.; sol. in water; melts below 100° ; loses its cryst. water, with further decomp. at higher temp.	$\text{Hg}_2\text{SiF}_6.2\text{H}_2\text{O}$, <i>mercury silicofluoride, mercurous silicofluoride, mercurous fluosilicate.</i> Clear, prismatic cryst.; sl. sol. in water; more easily sol. in acidified water, but pptd. by HCl.	$\text{HgSiF}_6.6\text{H}_2\text{O}$, <i>mercury silicofluoride, mercuric silicofluoride, mercuric fluosilicate.</i> Clear, colorless, rhombohedral cryst.; sometimes star shaped; very unstable; deliq. in air; efflor. over H_2SO_4 ; easily sol. in water.
Sulfate	Ag_2SO_4 , <i>silver sulfate, normal silver sulfate.</i> Small, white, lustrous, rhombic or prismatic cryst.; sl. sol. in water; more sol. in dil. H_2SO_4 than in pure water; still more sol. in dil. HNO_3 and still more in concd. H_2SO_4 , from which it is pptd. by water; sol. in NH_4OH or $(\text{NH}_4)_2\text{CO}_3 + \text{Aq.}$; decrepitates at c. 300° ; M. P. 652° ; decomp. at very high temp., giving Ag, SO_2 and O_2 ; sp. gr. 5.5.	PbSO_4 , <i>lead sulfate, normal lead sulfate, anglesite, lead vitriol.</i> Heavy, white, amorph. powder, or small, rhombic cryst.; nearly insol. in water; insol. in dil. H_2SO_4 or alcohol; sol. in hot, concd. H_2SO_4 , HCl, HNO_3 or $\text{NaOH} + \text{Aq.}$; sol. in warm NH_4OH and in $\text{NH}_4\text{C}_2\text{H}_3\text{O}_2 + \text{Aq.}$; also in $(\text{NH}_4)_2\text{C}_4\text{H}_4\text{O}_6 + \text{Aq.}$; melts at red heat or 1170° without decomp., but decomp. at white heat to PbO , SO_2 and O_2 ; sp. gr. 6.2.	Hg_2SO_4 , <i>mercury sulfate, mercurous sulfate, normal mercurous sulfate.</i> Heavy, white, cryst. powder, or small, monoclinic prisms that collect in tufts or cross-shaped masses; gray on exposure to light; sl. sol. in water; easily sol. in dil. HNO_3 , but repptd. therefrom by dil. H_2SO_4 ; somewhat sol. in cold, abundantly in hot, dil. H_2SO_4 ; melts at a low, red heat to a deep red brown liquid and cools to a white cryst. mass; decomp. at a higher temp., giving off SO_2 and O_2 , and	HgSO_4 , <i>mercury sulfate, mercuric sulfate, normal mercuric sulfate.</i> White powder, or opaque masses, or lustrous leaflets in star-shaped groups; decomp. by water to an insol. basic salt and a sol. acid salt; sol. in acids or decomp. thereby; insol. in concd. alcohol; becomes first yellow, then red when heated; decomp. at red heat without melting to Hg , O_2 , SO_2 and Hg_2SO_4 ; sp. gr. 6.5.

Ag, Pb, Hg, Cu, Cd, Bi GROUP

Copper(cuprous)	Copper(cupric)	Cadmium	Bismuth	Phosphite Cont.
Unknown.	CuSiO₃ , <i>copper silicate, cupric silicate, cupric metasilicate</i> . Greenish blue ppt.; insol. in water; decomp. by acids.	2CdSiO₃·3H₂O , <i>cadmium silicate, cadmium metasilicate</i> . Microscopic needles; insol. in water; decomp. by acids, with separation of silicic acid.	Bi₂(SiO₃)₃ , (?) <i>bismuth silicate, agricolite, eulytite</i> . Powder of doubtful compn.; insol. in water; decomp. by HCl.	Silicate
Cu₂SiF₆ , <i>copper silicofluoride, cuprous silicofluoride, cuprous fluosilicate</i> . Copper-red solid similar to Cu ₂ F ₂ ; insol. in water; melts at high temp., evolving SiF ₄ .	CuSiF₆·6H₂O , <i>copper silicofluoride, cupric silicofluoride, cupric fluosilicate</i> . Blue, transparent, hygroscopic, rhombohedral or prismatic cryst.; sol. in water; loses 2H ₂ O at 60° and becomes opaque; decomp. at 140°.	CdSiF₆ , <i>cadmium silicofluoride, cadmium fluosilicate</i> . Long, deliq., prismatic cryst.; very easily sol. in water.	Unknown.	Silico-fluoride
Unknown.	CuSO₄·5H₂O , <i>copper sulfate, cupric sulfate, normal cupric sulfate, blue vitriol, blue stone, copper vitriol, blue copperas, calcanthite, Roman vitriol</i> . Large, blue, transparent, triclinic cryst.; superficially efflor. in dry air, giving off 2H ₂ O; decomp. at 20°; heated for some time at c. 100° it loses 4H ₂ O, the last H ₂ O going off at c. 230°; strongly metallic taste; sol. in water, 14 g. of the anhydrous salt in 100 g. of water at 0°, 21 g. at 20°, 75 g. at 100°; insol. in abs. alcohol;	3CdSO₄·8H₂O , <i>cadmium sulfate, normal cadmium sulfate</i> . Large, transparent, monoclinic tabular cryst.; efflor. in air; sol. in water, 76 g. of the anhydrous salt in 100 g. of water at 0°, 77 g. at 20°, 61 g. at 100°; insol. in alcohol; loses all its cryst. water at low red heat. CdSO₄ , <i>anhydrous cadmium sulfate</i> . White, hygroscopic powder; sol. in water.	Bi₂(SO₄)₃ , <i>bismuth sulfate, normal bismuth sulfate</i> . Small, white, lustrous, very deliq. needles, or amorph. powder; with water at 100° it forms Bi ₂ (SO ₄) ₃ ·3H ₂ O; decomp. by boiling with water to a basic Bi sulfate; sol. in HNO ₃ .	Sulfate

Ag, Pb, Hg, Cu, Cd, Bi GROUP

Sulfate
Cont.

Silver	Lead	Mercury(ous)	Mercury(ic)
		partially subliming; slowly changed by boiling water to an acid salt and a yellow powder, which is probably a basic salt; sp. gr. 7.6.	
AgHSO₄ , <i>acid silver sulfate, silver bisulfate</i> . Pale yellow prisms; compn. varies with the amount of H ₂ SO ₄ in the soln. from which the cryst. separate; decomp. by water; sol. in H ₂ SO ₄ . Basic silver sulfate unknown.	Pb(HSO₄)₂·H₂O , <i>acid lead sulfate, lead bisulfate</i> . White powder; decomp. by water; sol. in dil. H ₂ SO ₄ .	Hg₂(HSO₄)₂ , <i>acid mercurous sulfate, mercurous bisulfate</i> . Said to be rhombic prisms.	Hg(HSO₄)₂ , <i>acid mercuric sulfate</i> . Of doubtful existence.
	2PbO·SO₃ , <i>basic lead sulfate, sublimated white lead, lanarkite, galenite, nonpoisonous white lead, patent white lead, purex</i> . White, cryst. powder, consisting of clear, microscopic needles, or narrow, serrated leaflets; not entirely insol. in water; decomp. by dil. acids, even HC ₂ H ₃ O ₂ , with formation of PbSO ₄ ; melts when heated, becoming yellow, but turning white on cooling.	Basic mercurous sulfate unknown.	3HgO·SO₃ , <i>basic mercuric sulfate, Turpeth mineral, Turbith mineral, queen's yellow</i> . Heavy, lemon-yellow powder; odorless; almost tasteless; nearly insol. in water; sl. sol. in warm, dil. H ₂ SO ₄ ; sol. in warm, concd. HCl; turns red when heated.
No double sulfates are known.	Pb(NH₄)₂(SO₄)₂ , <i>lead ammonium sulfate</i> . Small, clear cryst.; water dissolves out the (NH ₄) ₂ SO ₄ ; decomp. at red heat.	No double sulfates are known.	3HgSO₄·(NH₄)₂SO₄·2H₂O , <i>mercury ammonium sulfate, mercuric ammonium sulfate</i> . Large, monoclinic cryst.; turns dark in the light; difficultly

Copper(cuprous)	Copper(cupric)	Cadmium	Bismuth
Acid cuprous sulfate unknown.	sol. in HCl, with reduction of temp.; very sl. sol. in concd. H_2SO_4 ; insol. in $\text{HC}_2\text{H}_3\text{O}_2$; sp. gr. 2.3. CuSO_4, anhydrous copper sulfate, anhydrous cupric sulfate. White, or grayish white, amorph. or cryst. powder; sometimes white or colorless, prismatic cryst.; absorbs water from the air; sol. in water, with great evolution of heat; decomp., partly at red heat, wholly at white heat to SO_2 , O_2 and CuO ; M. P. 200° ; sp. gr. 3.6. Acid cupric sulfate unknown.	Acid cadmium sulfate unknown.	$\text{BiH}(\text{SO}_4)_2 \cdot 3\text{H}_2\text{O}$, acid bismuth sulfate, bismuth bisulfate. White powder; insol. in water; easily sol. in acids, especially HCl or HNO_3 .
Basic cuprous sulfate unknown.	$8\text{CuO} \cdot \text{SO}_3 \cdot 12\text{H}_2\text{O}$, basic copper sulfate, basic cupric sulfate. Apple-green, amorph. powder that turns blue as it dries; insol. in water; sol. in mineral acids; loses $6\text{H}_2\text{O}$ at 149° , the rest at 260° . Many other basic copper sulfates are said to exist.	$2\text{CdO} \cdot \text{SO}_3 \cdot 2\text{H}_2\text{O}$, basic cadmium sulfate. Cryst. scales; difficultly sol. in cold water; sl. sol. in hot water.	$x\text{Bi}_2\text{O}_3 \cdot y\text{SO}_3 \cdot z\text{H}_2\text{O}$, basic bismuth sulfate. White cryst. or amorph. powder; insol. in water; sol. in H_2SO_4 or HNO_3 .
No double cuprous sulfates are known.	$\text{CuK}_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$, copper potassium sulfate, cupric potassium sulfate. Pale blue, monoclinic cryst.; easily sol. in water; decomp. into a basic salt by boiling;	$\text{Cd}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$, cadmium ammonium sulfate. Small, monoclinic cryst.; stable in air; sol. in water; dries with difficulty, but efflor. over H_2SO_4 ;	No double sulfates are known.

Sulfate
Cont.

Ag, Pb, Hg, Cu, Cd, Bi GROUP

	Silver	Lead	Mercury(ous)	Mercury(ic)
Sulfate Cont.				sol. in water; easily sol. in NH_4OH .
Sulfide	Ag_2S, silver sulfide, argentous sulfide, silver subsulfide. Deep black, amorph. powder; insol. in water, but decomp. to Ag_2S and Ag by standing under water, or by drying; easily sol. in warm, dil. HNO_3, and in concd. H_2SO_4, without separation of S; sol. in concd. $\text{KCN} + \text{Aq}$. Ag_3S, silver sulfide, argentic sulfide, silver glance, acanthite, argentine, glance ore, glass ore, soft ore. Heavy, black, amorph. ppt.; native in dark gray cryst. with metallic luster; melts easily; when melted out of air it solidifies to a dark gray, lustrous malleable mass, that can be cut with a knife; when slowly heated in air it gives Ag and SO_2; insol. in water; sol. in hot, dil. or concd. HNO_3, with separation of S and evolution of NO; decomp. by hot, concd. HCl, forming AgCl and	PbS, lead sulfide, lead monosulfide, plumbous sulfide, galena, galenite, blue lead. Brownish black amorph. powder when pptd.; lead-gray cryst. solid when made by fusion of Pb and S; blue-gray, lustrous, cubic or octahedral cryst. when native; melts at red heat or 1114°, out of contact with air, occasionally subliming; heated in air it evolves SO_2 and forms Pb and SO_2 and some PbO; heated with PbO it forms Pb and SO_2; heated with Fe it gives Pb and FeS; insol. in water, cold, dil. acids, alkalies, and alkaline sulfides; hot, dil. HNO_3 forms $\text{Pb}(\text{NO}_3)_2$, S and NO; concd. HNO_3 forms PbSO_4 and S; sol. in concd. HCl, forming PbCl_2 and H_2S; aqua regia forms PbCl_2 and PbSO_4; sp. gr. 7.5. PbS_2, lead sulfide, lead persulfide. Blood-red amorph. ppt.; unstable in	Hg_2S, mercury sulfide, mercurous sulfide. Black, amorph. powder that is considered by many as only a varying mixture of HgS and Hg; easily decomp. by heat to HgS and Hg; insol. in water, dil. HNO_3, hot NH_4OH or $(\text{NH}_4)_2\text{S} + \text{Aq}$; sol. in $\text{KOH} + \text{Aq}$, with separation of Hg; hot, concd., or cold, fuming HNO_3 converts it partly to white, insol. 2HgS. $\text{Hg}(\text{NO}_3)_2$ and partly to sol. $\text{Hg}(\text{NO}_3)_2$.	HgS, mercury sulfide, mercuric sulfide, cinnabar, vermilion, Chinese red, Ethiops mineral, metacinnabarite, red mercury sulfuret, mercury blend, liver ore, patent red. Occurs in two forms: black, amorph. powder and red cryst. Amorph. HgS. Heavy, black, amorph. powder; insol. in water or $(\text{NH}_4)_2\text{S} + \text{Aq}$; not affected by dil. acids; sl. decomp. by hot, concd. HCl; sol. in cold aqua regia; concd. HNO_3 gives $\text{Hg}(\text{NO}_3)_2$, mixed with HgSO_4; continued boiling with concd. HNO_3 gives white insol. 2HgS. $\text{Hg}(\text{NO}_3)_2$; sublimes to red HgS when heated in a closed tube; when heated in air Hg sublimes and SO_2 is formed; reduced to Hg and a metallic sulfide when heated with Fe, Sn, Sb, Cu or Zn. Cryst. HgS. Cochineal-red to brown, hexagonal, rhombohedral

Copper(cuprous)	Copper(cupric)	Cadmium	Bismuth
	loses 3H ₂ O at 100°, the rest at higher temp., leaving a colorless mass that melts at red heat. Cu(NH₄)₂(SO₄)₂·6H₂O , copper ammonium sulfate, cupric ammonium sulfate. Clear, blue, monoclinic cryst.; efflor. in warm, dry air; easily sol. in water; loses its cryst. water at 120°; melts at higher temp. to a green liquid, which at red heat decomp., leaving CuSO ₄ .	loses all its cryst. water at 100°; melts at higher temp. with decomp., leaving a basic Cd sulfate.	
Cu₂S , copper sulfide, cuprous sulfide, copper glance, chalcocite, carmenite. Grayish-blue amorph. powder or solid; or regular octahedra; or rhombic cryst.; insol. in water or (NH ₄) ₂ S+Aq; sl. sol. in hot, concd. HCl, forming CuCl ₂ ; cold HNO ₃ forms CuS and Cu(NO ₃) ₂ ; hot HNO ₃ forms Cu(NO ₃) ₂ , with separation of S and evolution of NO; decomp. by concd. H ₂ SO ₄ , forming CuS, CuSO ₄ and SO ₂ ; melts more easily than Cu; heated in air gives CuO, SO ₂ and CuSO ₄ ; heated out of contact with air it gives Cu and CuS; frequently found in nature in combination with other metallic sulphides; M. P. 1130°; sp. gr. 5.7.	CuS , copper sulfide, cupric sulfide, covellite. Brownish-black, amorph. ppt. that becomes greenish-black when dried, and dark blue when melted; or lustrous, indigo blue or dark blue hexagonal tablets; stable in dry air when dry; oxidizes slowly to CuSO ₄ , when moist and exposed to air; insol. in water; difficultly sol. in hot concd. HCl, forming CuCl ₂ ; easily sol. in hot HNO ₃ , with formation of Cu(NO ₃) ₂ , S and NO; insol. in hot, dil. H ₂ SO ₄ ; concd. H ₂ SO ₄ forms CuSO ₄ , S and SO ₂ ; sol. in KCN+Aq; frequently found native, combined with sulfides of As and Sb; sp. gr. 4.6. Colloidal CuS . The aq. soln. of CuS is dark-colored, with sl. greenish fluorescence; the CuS is pptd. by the addition of solns. of various salts, e. g. sulfates and nitrates.	CdS , cadmium sulfide, greenockite, cadmium blend, cadmia, Jaune brilliant, Naples yellow, Paris yellow, pale cadmium, orient yellow, radiant yellow, aurora yellow, cadmium red, cadmium yellow or cadmium orange, according to the color. Amorph. powder or solid; light yellow when freshly pptd.; when dried and heated it turns orange-yellow, then brown, finally carmine; sometimes hexagonal prisms; insol. in water or (NH ₄) ₂ S+Aq; difficultly sol. in hot, dil. HCl; easily sol. in cold, concd. HCl; sol. in hot, dil. H ₂ SO ₄ ; HNO ₃ forms Cd(NO ₃) ₂ , S and NO; forms CdO when heated to a high temp.; M. P. 1750° at 100 atmospheres; sp. gr. 4.8. Colloidal CdS . Golden-yellow, fluorescent, transparent, aq. soln. CdS₈ , cadmium pentasulfide.	Bi₂S₃·2H₂O , (?) bismuth sulfide, bismuth bisulfide, bismuth subsulfide, bismuth disulfide. Dull, black, amorph. powder of doubtful compn.; becomes lustrous by compression; insol. in water; decomp. by HCl to Bi, BiCl ₃ and H ₂ S; decomp. by heat to Bi and Bi ₂ S ₃ . Bi₂S₃ , bismuth sulfide, bismuth trisulfide, bismuthinite. Black, amorph. ppt. or steel-gray cryst., lustrous solid; insol. in water or (NH ₄) ₂ S+Aq; sol. in hot HCl, with separation of S; sol. in dil. HNO ₃ , forming Bi(NO ₃) ₃ , S and NO; melts when strongly heated and then decomp. into Bi and S; sp. gr. 7.4.

Sulfate
Cont.

Sulfide

Ag, Pb, Hg, Cu, Cd, Bi GROUP

Sulfide
Cont.

Silver	Lead	Mercury(ous)	Mercury(ic)
H ₂ S; coned. H ₂ SO ₄ gives Ag ₂ SO ₄ and SO ₂ ; M. P. 825°; sp. gr. 7.3.	air or water. Pb ₃ S and Pb ₂ S, lead subsulfides. Of doubtful existence.		cryst.; metallic luster; scarlet-red when powdered; blackens on exposure to light; insol. in water, alcohol, or dil. acids; decomp. by hot, dil. HNO ₃ , with separation of S and sometimes leaving white, insol. 2HgS.Hg(NO ₃) ₂ ; not decomp. by HCl, but easily by aqua regia; hot H ₂ SO ₄ gives HgSO ₄ and SO ₂ ; becomes brownish when heated to a low temp., brown at c. 250°, and black at higher temp., but returns to red on cooling; melts above 250° and then sublimes; sp. gr. 7.5 to 8.1. Colloidal HgS. Sol. in water, forming a soln. which is black and opaque when coned., but brown, with a greenish tint by reflected light, when dil.

Sulfite

Ag ₂ SO ₃ , silver sulfite, normal silver sulfite. Small, white, lustrous cryst. or cryst. ppt.; darkens in air, becoming first purple, then black; decomp. when heated dry or with water, giving Ag ₂ SO ₄ , Ag and SO ₂ ; very sl. sol. in cold water; easily sol. in NH ₄ OH or solns. of alkali sulfites; insol. in H ₂ SO ₄ +Aq; decomp. by strong acids, but not by HC ₂ H ₃ O ₂ .	PbSO ₃ , lead sulfite, normal lead sulfite. White, amorph. or lumpy powder; insol. in water; sl. sol. in H ₂ SO ₄ +Aq; decomp. by acids; HCl gives SO ₂ and PbCl ₂ ; H ₂ SO ₄ gives SO ₂ and PbSO ₄ ; coned. HNO ₃ oxidizes it to PbSO ₄ ; sol. in dil. HNO ₃ ; decomp. by heat to SO ₂ , PbS and PbSO ₄ . Basic lead sulfite is said to exist, but its formula is not known; white amorph. powder; stable in air; insol. in water.	Hg ₂ SO ₃ , mercury sulfite, mercurous sulfite, hypomercurosic sulfite. (?) Yellow, amorph. powder; turns yellowish brown when dried; turns white when heated in a closed tube; melts to a brownish red liquid that evolves SO ₂ and gives a sublimate of Hg and Hg ₂ SO ₄ ; insol. in cold water; decomp. by water on standing at ordinary temp. or by heating to 100°, giving Hg and Hg ₂ SO ₄ ; nearly insol. in HCl and H ₂ SO ₄ ; coned. HCl evolves SO ₂ and forms Hg ₂ Cl ₂ ; HNO ₃ evolves red fumes.	HgSO ₃ , mercury sulfite, mercuric sulfite, normal mercuric sulfite. White, amorph. ppt.; seldom found pure; generally contaminated with basic sulfite; insol. in water; sometimes decomp. by water; boiling water gives Hg and Hg ₂ SO ₄ ; turns red in the light with decomp. 2HgO.SO ₂ , basic mercuric sulfite. Heavy, white, cheese-like ppt.; insol. in water; sol. in HCl or solns. of alkali sulfites, with subsequent decomp. to a brownish ppt.; sol. in KCN+Aq. Hg(HSO ₃) ₂ , (?) acid mercuric sulfite. Heavy, white, cryst. ppt. or microscopic cubes; decomp. below 100°, turning black from formation of Hg; sol. in water, but decomp. by boiling.
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Tartrate

Ag ₂ C ₄ H ₄ O ₆ , silver tartrate. Amorph., curdy ppt., or fine, white powder, or white scales; insol. in water; sol. in HNO ₃ and NH ₄ OH; the emulsion in water deposits a mirror of Ag when heat-	PbC ₄ H ₄ O ₆ , lead tartrate. White, cryst. powder; insol. in water; very sol. in HNO ₃ .	Hg ₂ C ₄ H ₄ O ₆ , mercury tartrate, mercurous tartrate. White, cryst. powder; sl. sol. in water; sol. in acids.	HgC ₄ H ₄ O ₆ , mercury tartrate, mercuric tartrate. White, cryst. powder that darkens on exposure to light; sl. sol. in water; sol. in acids.
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Copper(cuprous)	Copper(cupric)	Cadmium	Bismuth
		Amorph. masses, light yellow when moist, orange yellow when dry; may be simply a mixture of CdS and S.	
Cu₂SO₃·H₂O, <i>cupper sulfite, cuprous sulfite, normal cuprous sulfite</i>. Occurs in two forms: (a) white and (b) red. <i>White</i>. Heavy, white, cryst. ppt. or microscopic hexagonal tablets with mother-of-pearl luster; insol. in water or alcohol; changed to the red variety by digestion with SO₂. <i>Red</i>. Rectangular, prismatic cryst.; red in color, resembling brick dust or red lead; insol. in water or alcohol; sol. in NH₄OH or dil. HCl to a colorless soln.	Normal cupric sulfite unknown. xCuO.ySO₃.zH₂O, <i>basic cupric sulfite</i>. Reddish yellow, amorph. powder; sl. sol. in water; decomp. by boiling water to CuSO₄, with separation of a brown powder, probably CuSO₃, which decomp. to CuO and SO₂ by continued boiling; the dry salt is decomp. by heat. Cu₂SO₃·CuSO₃·2H₂O, <i>cupro-cupric sulfite, dihydrated cupro-cupric sulfite</i>. Translucent, lustrous, cochineal-red or dark garnet-red, scaly or octahedral cryst.; sometimes forms curious cross-like groups of microscopic needles; stable in air; oxidizes in air when moist to CuSO₄ and a basic salt; nearly insol. in cold water; decomp. by boiling water, giving SO₂, Cu₂O, CuSO₄ and some CuS, but above 200° some metallic Cu is formed; NH₄OH dissolves it with a deep blue color; very dil. HNO₃ dissolves it with difficulty to a colorless soln., without evolving any gas; sol. in H₂SO₄+Aq; sol. in HCl to a brown colored soln. that turns green when diluted; decomp. when heated to a high temp. Cu₂SO₃·CuSO₃·5H₂O, <i>cupro-cupric sulfite, pentahydrated cupro-cupric sulfite</i>. Light, flocculent, yellow ppt.; insol. in water; forms the red dihydrate when boiled with water; easily sol. in H₂SO₄+Aq; sol. in HC₂H₃O₂ to a greenish soln., in solns. of cupric salts to an emerald green soln., and in NH₄OH to an intense blue soln.; HCl decomp. it, forming SO₂, Cu₂Cl₂ and CuCl₂.	CdSO₃, <i>cadmium sulfite, normal cadmium sulfite</i>. White, indistinctly cryst. masses or amorph. powder; difficultly sol. in water; easily sol. in dil. acids; when heated it gives SO₂, CdO, CdS and CdSO₄. CdSO₃·2H₂O, <i>cadmium sulfite</i>. Small cryst. with silvery luster; difficultly sol. in water; sol. in H₂SO₄+Aq or NH₄OH; insol. in alcohol.	Normal salt unknown. 2Bi₂O₃·3SO₂·5HO, <i>basic bismuth sulfite</i>. Insol. in water or alcohol; sl. sol. in H₂SO₄+Aq.
Cuprous salt unknown.	CuC₄H₄O₆·3H₂O, <i>copper tartrate, cupric tartrate</i>. Light blue or light green, amorph. powder; decomp. when heated; sl. sol. in water; readily sol. in H₂C₄H₄O₆+Aq and in solns. of alkalies; sol in acids	CdC₄H₄O₆·xH₂O, <i>cadmium tartrate</i>. Fine, white, cryst. powder; sparingly sol. in water; sol. in acids.	Bi₂(C₄H₄O₆)₃·6H₂O, <i>bismuth tartrate</i>. Small cryst.; insol. in water or decomp. thereby; sol. in acids.

Sulfide
Cont.

Sulfite

Tartrate

Ag, Pb, Hg, Cu, Cd, Bi GROUP

	Silver	Lead	Mercury(ous)	Mercury(ic)
Tartrate Cont.	ed; its ammoniacal soln. acts the same way. AgHC₄H₄O₆, acid silver tartrate. Monoclinic tablets.			
Thiocyanate	AgSCN , silver thiocyanate, silver sulfocyanide, silver sulfocyanate. White, cheese-like ppt.; darkens slowly in air; insol. in water, and dil. acids; sol. in concd. H ₂ SO ₄ or HNO ₃ ; insol. in dil. sol. in concd. NH ₄ OH; sol. in KSCN+Aq; insol. in AgNO ₃ +Aq or NH ₄ SCN+Aq.	Pb(SCN)₂ , lead thiocyanate, lead sulfocyanide, lead sulfocyanate. Yellow, lustrous, microscopic, monoclinic cryst.; very sl. sol. in cold water; decomp. by boiling water; HNO ₃ oxidizes it to PbSO ₄ . Pb(SCN)₂.PbO. H ₂ O, basic lead thiocyanate, basic lead sulfocyanide. White, cheese-like ppt., which turns to a yellow powder when dried; insol. in water.	Hg₂(SCN)₂ , mercury thiocyanate, mercurous thiocyanate, mercury sulfocyanide, mercurous sulfocyanide, mercurous sulfocyanate. White ppt.; insol. in water; slightly attacked by HNO ₃ ; sol. in hot HCl and in hot KSCN+Aq, with separation of Hg; decomp. by H ₂ S, or aqua regia.	Hg(SCN)₂ , mercury thiocyanate, mercuric thiocyanate, mercury sulfocyanide, mercuric sulfocyanide, mercuric sulfocyanate. White to grayish white powder or colorless needles with sharp, metallic taste; very sl. sol. in cold, much more easily sol. in hot water; sol. in HgCl ₂ +Aq, Hg(NO ₃) ₂ +Aq, KSCN+Aq or NH ₄ Cl+Aq; moderately sol. in alcohol; easily sol. in dil. HCl; when heated it swells up, giving off Hg vapors, N ₂ and CS ₂ , and leaving behind a yellowish gray or brownish gray mass like graphite; easily forms double thiocyanates by dissolving in other thiocyanates.
Thio-sulfate	Ag₂S₂O₃ , silver thiosulfate, silver hyposulfite. Grayish white, flocculent ppt. or snow-white, amorph. powder; sweet taste; when freshly pptd. it changes in color rapidly from white, thru yellow and brown to black, being decomp. by water to Ag ₂ S and H ₂ SO ₄ ; sl. sol. in water, but easily decomp. thereby; sol. in NH ₄ OH and in alkali thiosulfate solns.	PbS₂O₃ , lead thiosulfate, lead hyposulfite. White or gray powder or solid; blackens on standing in air; decomp. when heated; nearly insol. in water; sol. in HNO ₃ ; sol. in solns. of alkali thiosulfates, probably forming sol. double thiosulfates.	Hg₂S₂O₃ , mercury thiosulfate, mercurous thiosulfate, mercurous hyposulfite. The normal salt has never been isolated; it is known only as a double salt in 3Hg ₂ S ₂ O ₃ .5Cu ₂ S ₂ O ₃ , a brownish-red, amorph. powder which is insol. in water, but sol. in HNO ₃ and decomp. when heated.	HgS₂O₃ , mercury thiosulfate, mercuric thiosulfate, mercuric hyposulfite. The normal salt has never been isolated; it is known only as double salts; the most common one is 3HgS ₂ O ₃ .5K ₂ S ₂ O ₃ , fine, white needles that taste bitter, darken in air, decomp. when heated, and dissolve in water, but not in alcohol.

Copper(cuprous)	Copper(cupric)	Cadmium	Bismuth
$\text{Cu}_2(\text{SCN})_2$, copper thiocyanate, cuprous thiocyanate, copper sulfocyanide, cuprous sulfocyanide, cuprous sulfocyanate. White or grayish white amorph. powder; insol. in water or dil. acids; sl. sol. in cold, easily in warm, concd. HCl; decomp. by concd. HNO_3 or H_2SO_4; sol. with combination in NH_4OH, when freshly pptd.; insol. in $\text{KSCN} + \text{Aq}$; decomp. by heat.	$\text{Cu}(\text{SCN})_2$, copper thiocyanate, cupric thiocyanate, copper sulfocyanide, cupric sulfocyanide, cupric sulfocyanate. Ivory-black, cryst. powder; odorless when dry; decomp. by water, quickly when hot, to the cuprous salt, $\text{Cu}_2(\text{SCN})_2$ and HSCN, HCN and H_2SO_4; sol. in warm HCl, H_2SO_4 or HNO_3; sol. in NH_4OH; sol. in solns. of sulfocyanides, but the resulting solns. are decomp. by dilution; decomp. by heating above 100°.	$\text{Cd}(\text{SCN})_2$, cadmium thiocyanate, cadmium sulfocyanide, cadmium sulfocyanate. White, lustrous cryst.; sl. sol. in water; sol. in NH_4OH, with combination.	$\text{Bi}(\text{SCN})_3$, bismuth thiocyanate, bismuth sulfocyanide, bismuth sulfocyanate. Dark orange-red powder; insol. or sl. sol. in water or decomp. thereby; sol. in HNO_3, HCl or $\text{HSCN} + \text{Aq}$. $\text{Bi}(\text{SCN})_{3.2}\text{Bi}_2\text{O}_3$, basic bismuth thiocyanate, basic bismuth sulfocyanide. Yellow powder; insol. in water, but when recently pptd. decomp. by boiling therewith; insol. in $\text{HSCN} + \text{Aq}$.
Normal salt not known. $\text{Cu}_2\text{H}_4(\text{S}_2\text{O}_3)_2$, copper thiosulfate, acid cuprous thiosulfate, acid cuprous hyposulfite. Microscopic needles with golden luster; decomp. on exposure to air or when heated; sl. sol. in water; sol. without color in NH_4OH, $\text{NH}_4\text{Cl} + \text{Aq}$ or $(\text{NH}_4)_2\text{CO}_3 + \text{Aq}$, but the solns. turn blue on standing; easily sol. in $\text{Na}_2\text{S}_2\text{O}_3 + \text{Aq}$; sol. in acids, with separation of S.	Unknown.	$\text{CdS}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$, cadmium thiosulfate, cadmium hyposulfite. Cryst. masses or powder; deliq. in air; sol. in water; insol. in alcohol.	$\text{Bi}_2(\text{S}_2\text{O}_3)_3$, bismuth thiosulfate, bismuth hyposulfite. The normal salt is known only in soln. and is doubtful at that; double salts with alkali thiosulfates are known; the most common is $\text{Bi}_2(\text{S}_2\text{O}_3)_3 \cdot 3\text{K}_2\text{S}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$, a canary-green, amorph. ppt.; sol. in water; insol. in alcohol.

Tartrate
Cont.

Thio-
cyanate

Thio-
sulfate

Ag, Pb, Hg, Cu, Cd, Bi GROUP

Tungstate

Silver	Lead	Mercury(ous)	Mercury(ic)
Ag_2WO_4, <i>silver tungstate</i>, <i>silver orthotungstate</i>, <i>silver wolframate</i>, <i>raspite</i>, <i>stolzite</i>. Pale yellow, amorph. ppt.; melts below red heat, and becomes cryst. on cooling; nearly insol. in water; easily sol. in NH_4OH or HNO_3.	PbWO_4, <i>lead tungstate</i>, <i>lead orthotungstate</i>, <i>lead wolframate</i>. White, amorph. ppt.; insol. in water or cold HNO_3; decomp. by hot HNO_3; sol. in $\text{KOH} + \text{Aq}$.	Hg_2WO_4, <i>mercury tungstate</i>, <i>mercurous tungstate</i>, <i>mercurous orthotungstate</i>, <i>mercurous wolframate</i>. Yellow ppt.; insol. in water; impossible to obtain pure as it decomp. into a basic salt; leaves WO_2 when heated.	HgWO_4, <i>mercury tungstate</i>, <i>mercuric tungstate</i>, <i>mercuric orthotungstate</i>, <i>mercuric wolframate</i>. Amorph. ppt.; white, yellow, red or black; very unstable; nearly insol. in water.

Copper(cuprous)	Copper(cupric)	Cadmium	Bismuth	Tungstate
Unknown.	$\text{CuWO}_4 \cdot 2\text{H}_2\text{O}$, <i>cupper tungstate</i> , <i>cupric tungstate</i> , <i>cupric orthotungstate</i> , <i>cupric wolframate</i> . Bright green powder; melts at red heat and cools to chocolate-brown cryst. or masses containing CuWO_4 ; insol. in water; sol. in H_3PO_4 , $\text{HC}_2\text{H}_3\text{O}_2$ or NH_4OH ; insol. in $\text{H}_2\text{C}_2\text{O}_4 + \text{Aq}$.	$\text{CdWO}_4 \cdot 2\text{H}_2\text{O}$, <i>cadmium tungstate</i> , <i>cadmium orthotungstate</i> , <i>cadmium wolframate</i> . Yellowish amorph. ppt.; nearly insol. in water. CdWO_4 , <i>anhydrous cadmium tungstate</i> . Colorless, poorly formed cryst. or yellow, cryst. powder; insol. in water; sol. in $\text{KCN} + \text{Aq}$; sol. in hot $\text{H}_3\text{PO}_4 + \text{Aq}$ or $\text{H}_2\text{C}_2\text{O}_4 + \text{Aq}$; sol. in NH_4OH .	$\text{Bi}_2(\text{WO}_4)_3$, (?) <i>bismuth tungstate</i> , <i>bismuth orthotungstate</i> , <i>bismuth wolframate</i> . White powder; easily decomp.; very sol. in water with decomp.; pptd. by alcohol from aq. solns.	

GROUP VI

Arsenic	As
Antimony	Sb
Tin	Sn

The members of this group are generally gray, hard, heavy, lustrous, somewhat brittle metals or metal-like substances; stable in air; unaffected by water; soluble with considerable difficulty in acids. The valence is 2 and 4 in Sn, but 3 and 5 in each of the other two members. The *ous* and *ic* states are prominent in Sn and appear occasionally in As and Sb. Only a few salts are known; of these the halogen salts are soluble in water, the rest are generally insoluble in water. Most of the salts are white, but the sulfides are yellow or brown. All three elements enter salts in the acid radical; a few stannates and antimonates are known; the arsenites and arsenates are more common and are often colored. Bead tests and flame coloration tests are usually absent or unsatisfactory.

Metal

Arsenic	Antimony	Tin
As, arsenic, black arsenic, gray arsenic. Occurs in two forms, (1) fine, heavy, black, amorph. powder, and (2) tin-white to steel-gray, very brittle, cryst. masses with metallic luster; cryst. by sublimation in hexagonal rhombohedra; sometimes forms regular octahedra; odorless and tasteless, stable in air, but the cryst. variety slowly changes to the amorph. variety; in moist air it becomes covered with a coating of oxide; it volatilizes at a dark red heat without previous melting at ordinary pressures; vapor is citron-yellow; under increased pressure it melts at 500°; at 180° it burns with a bluish flame to As_2O_3, giving off a peculiar garlic-like odor; unites directly with many elements, particularly the halogens; in many of its physical properties As is metallic, but in its chemical relations it is decidedly non-metallic; unaffected by pure water; insol. in alcohol; insol. in HCl in absence of air; sl. sol. in HCl in presence of air, forming first As_2O_3 and then $AsCl_3$; not attacked by dil. H_2SO_4; concd. H_2SO_4 oxidizes it to As_2O_3, evolving SO_2; dil. HNO_3 does not act on As readily in the cold, in the hot it oxidizes the As to As_2O_3 or to H_3AsO_3; concd.	Sb, antimony, iron black. Brittle, hard, silver-white, highly lustrous, metal-like masses, with scale-like cryst. structure; or dark gray, sl. lustrous, cryst. powder; can be pulverized very easily; stable in air at ordinary temp.; when heated it burns with a blue or bluish white flame to Sb_2O_3; melts at 630.5°; vaporizes at bright, red heat, with formation of a little Sb_2O_3; insol. in water and does not decomp. it at ordinary temp.; at red heat Sb reduces steam, giving H_2 and Sb oxide; Sb is more metallic than As both physically and chemically; insol. in dil. HCl; sol. in hot, concd. HCl to $SbCl_3$, if Sb is finely powdered; contact with oxygen helps the reaction; the presence of a little HNO_3 hastens the action; insol. in dil. or cold, concd. H_2SO_4; hot, concd. H_2SO_4 forms SO_2 and $Sb_2(SO_4)_3$; unaffected by dil. HNO_3; concd. HNO_3 does not dissolve it, but oxidizes it to Sb_2O_3 or Sb_2O_5, according to the strength of the acid; easily and completely sol. in aqua regia to $SbCl_3$; insol. in solns. of alkalis; heating with metallic oxides, e. g. PbO_2, HgO or MnO_2, oxidizes it; combines directly with the halogens; forms alloys with many metals.	Sn, tin, white tin, black tin, gray tin. Lustrous metal; almost silver-white when pure, but with a yellowish tinge when commercial; found in bars, foil, powder and mossy; one of the least tenacious metals; very malleable and ductile; it can be beaten into very thin leaves (tin-foil) at ordinary temp., and at 100° it can be drawn into wire; malleable at ordinary temp., but malleability varies with the temp.; brittle above 200° and can be pulverized easily; has cryst. structure which can be shown by bending a bar and getting the "tin cry," which is said to be caused by the grating of the cryst. faces on each other, or by treating with HCl when frost-like etchings appear; great cold changes tin to a gray, brittle, amorph. powder, called "gray tin," said to be an allotropic form; it changes back to white tin above 20°; odorless at ordinary temp., but has a characteristic odor when warmed; Sn cryst. are rhombic and quadratic; Sn is metallic physically and in most of its chemical relations; commercial Sn often contains a little As, Cu, Fe and Pb; stable in dry air; insol. in water and unaffected thereby when cold; at red heat Sn decomp. water, giving SnO and H_2; when heated in air or oxygen a film of SnO and SnO_2 forms on the surface; burns at white heat, with white light, forming SnO_2; very sl. acted on by dil., cold HCl; sol. in hot, concd. HCl, forming H_2 and stannous chloride, $SnCl_2$; in the presence of Pt or a small amount of $PtCl_4$ soln. in HCl takes place more rapidly and at a lower temp.; readily sol. in cold aqua regia to stannic chloride, $SnCl_4$; slowly sol. in hot, dil. H_2SO_4, giving off H_2 and forming $SnSO_4$, if Sn is in excess, and mostly $Sn(SO_4)_2$, if acid is in excess; concd. H_2SO_4 dissolves Sn, forming $SnSO_4$ or $Sn(SO_4)_2$, according to the proportion of Sn to acid, and evolving H_2S or SO_2, or both, according to the temp. and the concentration of the acid; sometimes S separates; sol. in cold, dil. HNO_3, forming $Sn(NO_3)_2$ and NH_4NO_3 and evolving N_2O, NO and N_2; unaffected by pure, concd. HNO_3; HNO_3, depending upon the temp. and the concentration of the acid, forms stannous nitrate, $Sn(NO_3)_2$, or solid stannic nitrate, $Sn(NO_3)_4$, which separates and is converted by the increasing dilution of the acid, or by hot water to a basic nitrate and stannic acid, $SnO_2 \cdot xH_2O$, or stannic oxide, SnO_2; slowly sol. in $HCl \cdot H_2O$, with evolution of H_2; sol. in hot, concd. $NaOH + Aq$, forming Na_2SnO_3 and H_2; KOH acts similarly; Sn unites directly with the halogens; forms numerous alloys with other metals.

Arsenic	Antimony	Tin(stannous)	Tin(stannic)	Metal Cont.
HNO ₃ or aqua regia oxidizes it to H ₃ AsO ₄ , giving also As ₂ O ₃ and N oxides; insol. in NaOH+Aq, KOH+Aq or NH ₄ OH. At. No. 33; At. Wt. 74.96; Mol. Wt. 299.84; val. 3 and 5; sp. gr. cryst. 5.7, amorph. 4.7, yellow 2.0; M. P. 814° at 36 atmospheres; B. P. 615° under pressure; 1 isotope.	At. No. 51; At. Wt. 121.77; Mol. Wt. probably the same; val. 3 and 5; sp. gr. 6.684; M. P. 630.5°; B. P. 1380°; 2 isotopes.	At. No. 50; At. Wt. 118.70; Mol. Wt. unknown; val. 2 and 4; sp. gr. white 7.31, gray 5.750; M. P. 231.85°; B. P. 2260°; 7 or 8 isotopes.		
Unknown.	Unknown.	Sn(C ₂ H ₃ O ₂) ₂ , <i>tin acetate, stannous acetate</i> . Small, colorless cryst.; sol. in water.	Sn(C ₂ H ₃ O ₂) ₄ , <i>tin acetate, stannic acetate</i> . Gummy masses; sol. in water.	Acetate
Unknown.	SbAsO ₄ , (?) <i>antimony arsenate, antimony arseniate</i> . Heavy, white powder; insol. in water; when fresh it is sol. in hot, concd. HCl and sl. sol. in HNO ₃ ; insol. in acids after ignition.	2SnHAsO ₄ ·H ₂ O, <i>tin arsenate, stannous arsenate, stannous arseniate</i> . White, voluminous, flocculent ppt.; insol. in water; decomp. by heat to As, As ₂ O ₃ and SnO ₂ .	2SnO ₂ ·As ₂ O ₃ , <i>tin arsenate, stannic arsenate, stannic arseniate</i> . White, gelatinous ppt.; insol. in water or dil. HNO ₃ ; decomp. by NaOH. Sn ₂ (AsO ₄) ₃ ·6H ₂ O, <i>tin arsenate, stannic arsenate</i> . Insol. in water, HNO ₃ or H ₂ SO ₄ ; sol. in concd. HCl or in aqua regia. <i>Colloidal</i> . Very slowly sol. in water; reprecipitated by mineral acids or chloride solns. but not by alcohol.	Arsenate
Unknown.	SbAsO ₃ , (?) <i>antimony arsenite</i> . Fine, white ppt. or powder of doubtful compn.; sol. in a little water, but insol. in much water; sol. in acids, and completely sol. in KOH+Aq.	Sn ₂ (AsO ₃) ₂ , (?) <i>tin arsenite, stannous arsenite</i> . Ppt. of doubtful existence.	Sn ₂ (AsO ₃) ₄ , (?) <i>tin arsenite, stannic arsenite</i> . Ppt. of doubtful existence; insol. in water.	Arsenite
Unknown.	Unknown.	SnB ₂ O ₆ , (?) <i>tin borate, stannous borate</i> . Ppt. of doubtful existence; insol. in water; sol. in acids.	Unknown.	Borate
Unknown.	Unknown.	Sn(BrO ₃) ₂ , <i>tin bromate, stannous</i>	Sn(BrO ₃) ₄ , <i>tin bromate, stannic bro-</i>	Bromate

As, Sb, Sn GROUP

	Arsenic	Antimony	Tin(stannous)	Tin(stannic)
Bromate <i>Cont.</i>			<i>bromate</i> . Yellowish white powder; insol. in water; sol. in HCl.	<i>mate</i> . Said to exist.
Bromide	AsBr₃ , <i>arsenic bromide, arsenous bromide, arsenious bromide, arsenic tribromide</i> . Colorless, deliq. prisms; strong, arsenic odor; melts at 33° to a pale yellow liquid, which fumes but sl. in air, and boils at 220°; volatilizes unchanged, giving a cryst. sublimate; decomp. by a little water, forming AsOBr and HBr, by much water, forming As ₂ O ₃ and HBr; sol. in CS ₂ ; sp. gr. 3.5. AsOBr , <i>arsenic oxybromide, arsenyl bromide</i> . Dark, salve-like masses; insol. in water and alcohol; water dissolves out As ₂ O ₃ .	SbBr₃ , <i>antimony bromide, antimony tribromide</i> . Deliq., colorless or yellow cryst. masses; trimetric or rhombic cryst.; melts at 96.6°; boils at 270° to 280°; sublimes when heated; decomp. by water, with formation of SbOBr and HBr; sol. in CS ₂ or alcohol; sp. gr. 4.1. SbOBr , <i>antimony oxybromide, antimonyl bromide</i> . Brown powder; insol. in water or CS ₂ .	SnBr₂ , <i>tin bromide, stannous bromide, tin dibromide</i> . Hexagonal prisms, or greenish masses, or cryst. sl. yellow or gray, transparent solid; with cryst. water it forms colorless needles; melts at 215° to a transparent liquid, which boils at c. 225°; somewhat sol. in water; decomp. by water, with formation of SnOBr; sp. gr. 5.1.	SnBr₄ , <i>tin bromide, stannous bromide, tin tetrabromide</i> . Colorless or white cryst. or cryst. masses; decomp. slowly in air; sol. in cold water, with separation on cooling of colorless, lustrous cryst. of hydrated stannic bromide, SnBr ₄ ·4H ₂ O; decomp. by boiling water to the oxide; melts at 31° to a colorless liquid, which boils at c. 200°; decomp. by HNO ₃ or H ₂ SO ₄ ; sp. gr. 3.3. Sn₂OBr₆·12H₂O , <i>tin oxybromide, stannic oxybromide</i> . Colorless, prismatic cryst.; decomp. by water.
Carbide	AsC₃ , <i>arsenic carbide, arsenic tri-carbide</i> . Brown amorph. ppt.; explodes when warmed or rubbed, liberating As and C.	Unknown.	Unknown.	Unknown.
Carbonate	Unknown.	Unknown.	SnCO₃·SnO , <i>tin carbonate, basic stannous carbonate</i> . Heavy, white, cryst. powder; very unstable in air; insol. in water or H ₂ CO ₃ +Aq.	Unknown.
Chlorate	Unknown.	Unknown.	Sn(ClO₃)₂ , <i>tin chlorate, stannous chlorate</i> . Explosive, colorless liquid; sol. in water.	Unknown.
Chloride	AsCl₃ , <i>arsenic chloride, arsenous chloride, arsenious chloride, arsenic trichloride, butter of arsenic, caustic oil of arsenic, ar-</i>	SbCl₃ , <i>antimony chloride, antimonous chloride, antimonious chloride, antimony trichloride, butter of antimony, antimony</i>	SnCl₂ , <i>tin chloride, stannous chloride, tin dichloride, tin salt, salt of tin</i> . White, semitransparent, cryst. masses; frequently	SnCl₄ , <i>tin chloride, stannic chloride, tin tetrachloride, tin bichloride, butter of tin, fuming liquor of Libavius, pink salt, tin cryst-</i>

Arsenic	Antimony	Tin(stannous)	Tin(stannic)
<i>senic butter.</i> Heavy, fuming, poisonous, colorless, oily liquid that solidifies at -18° to white, lustrous needles; boils at 132°; decomp. by water or dil. HCl with formation of arsenic oxychloride, AsOCl; boiling water decomp. it to HCl and As_2O_3, a great part of the latter separating as a solid; sol. in concd. HCl, from which soln. it may be distilled unchanged but mixed with HCl; mixes with alcohol or ether; sp. gr. 2.2. AsOCl, <i>arsenic oxychloride, arsenyl chloride.</i> Hard, brownish, translucent, sl. fuming solid; absorbs O_2 from the air slowly; sol. in water with decomp.	<i>butter, mineral butter.</i> Colorless, translucent, deliq. cryst. mass; sometimes rhombic cryst.; very caustic; melts at 73° to a colorless or yellow liquid, which boils at 223°; decomp. by water, forming SbOCl; sol. in dil. HCl; sol. in alcohol without decomp.; very sol. in hot CS_2, but solubility diminishes rapidly on cooling; sp. gr. 3.1. SbCl_3, <i>antimony chloride, antimonie chloride, antimony pentachloride.</i> Colorless or sl. yellow liquid that solidifies when cooled to needle cryst. that melts at -2.8°; sharp, offensive, acid odor; fumes in moist air; solidifies to a cryst. mass by absorption of moisture; begins to boil at 140°, with partial decomp. to Cl_2 and SbCl_3; deliq. to $\text{SbCl}_3 \cdot 4\text{H}_2\text{O}$, which can be cryst. out of a little water; decomp. by more water into SbO_2Cl or SbOCl_2; sol. in a large amount of water if it is all added at one time; sp. gr. 2.3. SbOCl, <i>antimony oxychloride, antimonyl chloride.</i> From SbCl_3. White, amorph., cryst. powder or small, monoclinic cryst.; insol. in water, but decomp. when boiled therewith; sol. in CS_2 or HCl; insol. in alcohol or ether. SbOCl_2, <i>antimony oxychloride, antimonyl chloride.</i> From SbCl_3. Yel-	gray masses, with greasy luster and conchoidal fracture; absorbs O_2 from the air, forming insol. oxychloride; melts at 247° and boils at 617° to 628° with partial decomp.; at bright, red heat out of air some SnCl_4 is given off, then SnCl_2, and $\text{SnCl}_2 \cdot \text{SnO}$ remains; heated in air it gives SnCl_4 and SnO_2; not deliq.; sol. in a little water without decomp.; much water causes a ppt. of $\text{SnCl}_2 \cdot \text{SnO}$; the aq. soln. of SnCl_2 generally becomes turbid from pptn. of $\text{SnCl}_2 \cdot \text{SnO}$, but treatment with Sn and a little HCl dissolves the ppt. $\text{SnCl}_2 \cdot 2\text{H}_2\text{O}$, <i>hydrated tin chloride, tin salt.</i> Large, clear, monoclinic prisms or tablets, or octahedra; metallic taste; not deliq.; decomp. slowly on exposure to air, forming SnCl_4 and SnCl_2. SnO; melts in its cryst. water at 37° to 40°; when heated gradually to 100° most of its cryst. water goes off; when heated rapidly or to higher temp. it decomp. to H_2O, HCl, SnCl_4, and SnO; sol. in water. $\text{xSnO} \cdot \text{ySnCl}_2$. zH_2O, <i>tin oxychloride, stannous oxychloride.</i> Insol. in water; sol. in HCl.	<i>als.</i> Thin, mobile, colorless, fuming, caustic, very corrosive liquid; solidifies at -30° to small, white cryst.; boils at c. 120°; deliq. in air, probably forming hydrated stannic chloride; sol. in water, with production of much heat and considerable contraction in volume; a dil., aq. soln. of SnCl_4 decomp. gradually; diluting or boiling a clear solution of SnCl_4 ppts. SnO_2; very sol. in abs. alcohol, from which it is pptd. by water; easily sol. in ether; miscible with CS_2 and Br_2; dissolves cryst. S, also I and yellow P but not red P; decomp. by concd. HNO_3; sp. gr. 2.2. $\text{xSnO} \cdot \text{ySnCl}_4$. zH_2O, <i>tin oxychloride, stannic oxychloride.</i> White or yellowish white powder of varying compn.; sol. in water.

Chloride
Cont.

As, Sb, Sn GROUP

	Arsenic	Antimony	Tin(stannous)	Tin(stannic)
Chloride <i>Cont.</i>		lowish, cryst. ppt., which deliq. in air to a thick, yellow liquid; sometimes needle cryst.; decomp. by heat, probably to SbOCl and Cl_2 ; sol. in water or decomp. thereby; sol. in alcohol to a clear liquid. $2\text{SbOCl} \cdot \text{Sb}_2\text{O}_3$, <i>basic antimony chloride, powder of Algoroth, basic chloride, English powder.</i> White amorph. powder or fine grayish white, very lustrous, monoclinic needles; melts at high heat with decomp.; sol. in HCl ; decomp. by water.		
Chromate	Unknown.	$\text{Sb}_2(\text{CrO}_4)_3$ (?) <i>antimony chromate.</i> Of doubtful existence; insol. in water; sol. in acids.	SnCrO_4 , <i>tin chromate, stannous chromate, mineral lake.</i> Amorph. ppt.; insol. in water; sol. in dil. acids.	$\text{Sn}(\text{CrO}_4)_2$, <i>tin chromate, stannic chromate.</i> Amorph. ppt.
Cyanide	Unknown.	Unknown.	Unknown.	Unknown.
Ferro-cyanide	Unknown.	$\text{Sb}_3[\text{Fe}(\text{CN})_6]_3 \cdot 25\text{H}_2\text{O}$, <i>antimony ferrocyanide.</i> White or yellow, gelatinous ppt.; insol. in water.	$\text{Sn}_2\text{Fe}(\text{CN})_{12} \cdot 4\text{H}_2\text{O}$, <i>tin ferrocyanide, stannous ferrocyanide.</i> White or light green ppt.; insol. in water and acids; sl. sol. in NH_4OH .	$\text{SnFe}(\text{CN})_{12} \cdot 4\text{H}_2\text{O}$, <i>tin ferrocyanide, stannic ferrocyanide.</i> Brownish ppt.; insol. in water and acids.
Ferri-cyanide	Unknown.	Unknown.	Unknown.	Unknown.
Fluoride	AsF_3 , <i>arsenic fluoride, arsenious fluoride, arsenic trifluoride.</i> Colorless, transparent, mobile, very volatile, fuming liquid; solidifies to cryst. mass at 8.5° ; boils at c. 63° ; acts slowly on glass in a closed vessel, but exposed to air it absorbs moisture, forming As_2O_3 and HF , which etches the glass; sol. in water to a clear liquid, with production of much heat; the aq. soln. soon decomp. to As_2O_3 and HF ; miscible with alcohol or ether; sp. gr. 2.6.	SbF_3 , <i>antimony fluoride, antimonious fluoride, antimonious fluoride, antimony trifluoride.</i> White masses or colorless, transparent, deliq., trimetric, octahedral or prismatic cryst.; sol. in water without decomp.; does not fume in air; M. P. 292° ; sp. gr. 4.4. SbF_5 , <i>antimony fluoride, antimonious fluoride, antimony pentafluoride.</i> Amorph., gummy masses; decomp. by heat; sol. in water; M. P. 7° ; sp. gr. 2.9. SbOF_3 (?) <i>antimony oxyfluoride, antimonyl fluoride.</i> White masses; not deliq.	SnF_2 , <i>tin fluoride, stannous fluoride, tin difluoride.</i> Small, white, opaque, very lustrous, prismatic cryst.; easily sol. in water; heated in air it forms stannic oxyfluoride, SnOF_2 .	SnF_4 , <i>tin fluoride, stannic fluoride, tin tetrafluoride.</i> Has not been isolated; is known only in soln., which when heated yields tin oxyfluoride; sp. gr. 4.8. SnOF_2 , <i>tin oxyfluoride, stannic oxyfluoride.</i> White, amorph. powder; insol. in water.
Hydride	AsH_3 , <i>arsenic hydride, arsenic trihydride, arseniuretted hydrogen,</i>	SbH_3 , <i>antimony hydride, antimony trihydride, antimoniuretted hy-</i>	Unknown.	Unknown.

Arsenic	Antimony	Tin(stannous)	Tin(stannic)	Hydride Cont.
<i>arsine</i>. Colorless gas with disagreeable, garlic-like odor; frightfully poisonous; easily decomp. by heat to As and H₂; burns in air with pale blue flame to As₂O₃ and water; a black or brown, shiny spot of As is formed on cold porcelain held in the flame; liquefies at -55° to a colorless liquid which freezes at -119°; sl. sol. in water, 5 volumes at 15° and very sl. at 100°; sl. sol. in alcohol; absorbed and slowly decomp. by alkalies; decomp. by concd. acids to As and H₂; decomp. by Cl₂ with violence, by Br₂ and I₂ less so; sp. gr. 2.695; M. P. 113.5°. As₂H₃, <i>arsenic hydride, solid arsenic hydride</i>. Brown, velvety or silky, masses or powder; insol. in water, alcohol, ether and CS₂; sol. in concd. KOH+Aq; decomp. at 200°.	<i>drogen, stibine</i>. Colorless gas with nauseating smell resembling that of H₂S; extremely disagreeable taste; very poisonous; seldom obtained pure; usually mixed with H₂; sl. sol. in water, 20 volumes at 15°, but decomp. on long standing to Sb and H₂; easily decomp. by heat to Sb and H₂; decomp. by concd. H₂SO₄ or KOH+Aq; burns in air with grayish blue flame to Sb₂O₃ and water; stain on porcelain is black but less shiny than that of As; condenses to a colorless liquid of sp. gr. 2.26 which boils at -17° and solidifies to a white mass at -88°; 1500 volumes dissolve in 1 vol. of alcohol; sp. gr. 4.37.			
AsO₂H₃, not known as <i>arsenic hydroxide, arsenous hydroxide, arsenic hydrate</i>, or <i>arsenous hydrate</i>, but as H₃AsO₃, <i>arsenous acid, arsenious acid</i>. Known, not in free condition, but only in aq. soln., which has a sweetish, unpleasant, metallic taste, and is very sl. acid. AsO(OH)₃, not known as <i>arsenic hydroxide</i> or <i>arsenic hydrate</i>, but as H₃AsO₄, <i>arsenic acid</i>. White, amorph. masses	SbO₂H₃, <i>antimony hydroxide, antimonous hydroxide, antimonious acid, antimony hydrate, antimonous hydrate, antimonious hydrate, antimonous acid</i>. White, amorph. ppt.; insol. in water. SbO(OH)₃, not known as <i>antimonic hydroxide</i> or <i>antimonic hydrate</i>, but as H₃SbO₄, <i>antimonic acid, orthoantimonic acid</i>. White powder; almost insol. in water or HNO₃; when moist	SnO₂H₂.SnO, <i>tin hydroxide, stannous hydroxide, tin hydrate, stannous hydrate</i>. White or yellowish white, amorph. powder; insol. in water or NH₄OH; sol. in HNO₃, H₂SO₄, or HCl, forming the corresponding stannous salts; more easily sol. in acids than Sn or SnO; sol. in NaOH+Aq, even when dil.; sol. in KOH+Aq; boiling the soln. decomp. it to sol. K stannate, K₂SnO₃, while Sn	SnO₄H₄, not known as <i>tin hydroxide, stannic hydroxide, tin hydrate</i> or <i>stannic hydrate</i>, but as H₄SnO₄ and H₂SnO₃, <i>stannic acid</i>. White, voluminous, amorph. powder; insol. in water only when freshly made; easily sol. in acids, from which soln. it may be pptd. by dilution or boiling; sl. sol. in NH₄OH; easily sol. in KOH+Aq, but addition of large excess ppts. K₂SnO₃, which is	Hydroxide

As, Sb, Sn GROUP

	Arsenic	Antimony	Tin(stannous)	Tin(stannic)
Hydroxide Cont.	that dissolve in water to a colorless soln., which reacts acid and yields on evaporation rhombic cryst. of $2\text{H}_3\text{AsO}_4 \cdot \text{H}_2\text{O}$; these deliq. in air, dissolve in water, melt at 100° , losing the cryst. water and yielding H_3AsO_4 , orthoarsenic acid, which cryst. in fine, translucent needles; sol. in water; when heated to 180° it decomp. to $\text{H}_4\text{As}_2\text{O}_7$, pyroarsenic acid, hard, clear, glistening cryst.; sol. in water; still higher heat gives HAsO_3 , metarsenic acid, white cryst. or somewhat iridescent solid, sol. in water.	it turns blue litmus paper red.	separates; $\text{NaOH} + \text{Aq}$ acts similarly.	insol. in $\text{KOH} + \text{Aq}$; easily sol. in $\text{NaOH} + \text{Aq}$, but no ppt. is formed by an excess of the reagent. Two forms are known,—one called "stannic acid," the other "metastannic acid"; the solubilities of the two differ a little.
Hypo-chlorite	Unknown.	Unknown.	Unknown.	Unknown.
Hypo-phosphite	Unknown.	Unknown.	Unknown.	Unknown.
Iodate	Unknown.	Unknown.	$\text{Sn}(\text{IO}_3)_2$, (?) tin iodate, stannous iodate. Ppt.; sol. in $\text{SnCl}_2 + \text{Aq}$; insol. in $\text{NaIO}_3 + \text{Aq}$.	$\text{Sn}(\text{IO}_3)_4$, tin iodate, stannic iodate. Ppt. not fully investigated.
Iodide	AsI_3 , arsenic iodide, arsenous iodide, arsenious iodide, arsenic triiodide. Orange-red, glossy, cryst. masses or scales, occasionally rhombohedral cryst.; fracture of masses is violet colored; iodine odor and taste; melts when heated to 146° and then volatilizes to a yellow vapor that cryst. when it cools; decomp. at high temp.; sol. in alcohol, ether and CS_2 ; sl. sol. in HCl ; decomp. by a little water, with	SbI_3 , antimony iodide, antimonous iodide, antimony triiodide. Red cryst. which melt when heated to 167° , and volatilize to red vapor at high temp.; decomp. by water to insol. oxyiodide, SbOI and HI , which dissolves some of the SbI_3 ; sol. in $\text{HI} + \text{Aq}$; partly sol. in and partly decomp. by alcohol and ether; sol. in boiling CS_2 , but separates out on cooling; sol. in HCl and $\text{HC}_2\text{H}_3\text{O}_2$; decomp.	SnI_2 , tin iodide, stannous iodide, tin diiodide. Red, cryst. solid, or yellowish red, lustrous prisms; melts at 320° ; decomp. at high temp.; sl. sol. in cold, more in hot water without decomp.; much water decomp. it, forming tin oxyiodide; sol. in $\text{SnCl}_2 + \text{Aq}$; sl. sol. in CS_2 ; sol. in dil. HCl ; sol. in warm solns. of alkali chlorides and iodides; sol. in $\text{KOH} + \text{Aq}$. SnOI , tin oxyiodide. Ppt.; compn.	SnI_4 , tin iodide, stannic iodide, tin tetraiodide. Orange-red octahedra, or cryst. masses; melts at 143° , sublimes at 180° to reddish yellow needles, and boils at 295° ; sol. in CS_2 , ether and anhydrous alcohol; decomp. by water; sp. gr. 4.5.

Arsenic	Antimony	Tin(stannous)	Tin(stannic)	Iodide <i>Cont.</i>
formation of $2\text{AsOI} \cdot 3\text{As}_2\text{O}_3$, $12\text{H}_2\text{O}$; thin, pearly scales insol. in water; sol. in much water; the clear soln. if boiled down deposits pure AsI_3, but if left to cool slowly it deposits cryst. of As_2O_3 and AsI_3; sp. gr. 4.4. AsI_5, <i>arsenic iodide, arsenic pentiodide</i>. Brown, cryst. solid; easily decomp. to AsI_3 and I_2 by heat or by soln. in ether or CS_2; M. P. 76°; sp. gr. 3.9. AsI_3, <i>arsenic diiodide</i>. Thin, dark, cherry-red prisms; decomp. by water to AsI_3 and As; decomp. by alkalis; easily sol. in alcohol, ether or CS_2. AsOI, <i>arsenic oxyiodide</i>. Known only in combination with As_2O_3; see under AsI_3.	by H_2SO_4 and HNO_3; exists in three forms: (a) hexagonal, ruby-red cryst. by cryst. from CS_2; (b) trimetric, greenish-yellow cryst. by subliming the hexagonal cryst. not above 114°; and (c) monoclinic, red cryst., obtained by exposing a soln. of SbI_3 in CS_2 to direct sunlight; sp. gr. 4.8. SbI_3, <i>antimony iodide, antimonic iodide, antimony pentiodide</i>. Dark-brown, cryst. masses; very unstable; M. P. 79°. SbOI, <i>antimony oxyiodide</i>. Yellow ppt.; compn. varies with method of preparation; decomp. by acids.	varies with the method of preparation; insol. in water.		
Unknown.	Unknown.	Unknown.	Unknown.	Manganese
Of doubtful existence.	Of doubtful existence.	Unknown.	$\text{Sn}(\text{MoO}_4)_2$, (?) <i>stannic molybdate</i> . Insol. in water; sol. in HCl or $\text{KOH} + \text{Aq.}$	Molybdate
Unknown.	$\text{Sb}_2\text{O}_3 \cdot \text{N}_2\text{O}_5$, (?) <i>antimony nitrate</i> . Decomp. by cold water; sol. in concd. HNO_3 .	$\text{Sn}(\text{NO}_3)_2$, <i>tin nitrate, stannous nitrate</i> . Known generally in soln. from which insol. basic stannous nitrate, $\text{Sn}(\text{NO}_3)_2 \cdot \text{SnO}$, separates easily.	$\text{Sn}(\text{NO}_3)_4$, <i>tin nitrate, stannic nitrate</i> . Sol. in water, but decomp. quickly on standing; sol. and stable in HNO_3 .	Nitrate
Unknown.	Unknown.	Unknown.	Unknown.	Nitrite
Unknown.	$\text{Sb}_2(\text{C}_2\text{O}_4)_3$, (?) <i>antimony oxalate</i> . White powder; insol. in water; sol. in acids.	SnC_2O_4 , <i>tin oxalate, stannous oxalate</i> . Heavy, white, cryst. ppt.; insol. in water; sol. in acids.	$\text{Sn}(\text{C}_2\text{O}_4)_2$, (?) <i>tin oxalate, stannic oxalate</i> . Sol. in water.	Oxalate

As, Sb, Sn GROUP

Oxide

Arsenic	Antimony	Tin(stannous)	Tin(stannic)
As_2O_3, arsenic oxide, arsenous oxide, arsenious oxide, arsenic trioxide, white arsenic, "arsenic," arsenious anhydride, "arsenious acid," arsenic bloom, poison flour, flowers of arsenic, arsenite, arsenolite, claudetite, hydrach, arsenic glass, vitreous white arsenic. White, odorless, nearly tasteless, very poisonous powder, which is either amorph. or composed of minute, octahedral cryst.; very sl. sol. in water to a clear liquid, with metallic taste and feebly acid reaction; much more easily sol. in many acids than in water; more sol. in HCl than in H_2SO_4 or HNO_3, and still less in $\text{HC}_2\text{H}_3\text{O}_2$; decomp. by HNO_3 or aqua regia into As_2O_5; sol. in $\text{H}_3\text{PO}_4 + \text{Aq}$ and $\text{H}_2\text{C}_2\text{O}_4 + \text{Aq}$; easily sol. in fuming H_2SO_4; easily sol. in alkali hydroxides, forming solns. of arsenites; sol. in solns. of alkali carbonates; sol. in AsCl_3; very sl. sol. in absolute alcohol; nearly insol. in ether; sublimes without melting at 137° to a colorless, odorless vapor. A second modification is known, called "arsenic glass"; this is an amorph., vitreous, transparent, glass-like solid, which gradually becomes opaque because of formation of octahedral cryst.;	Sb_2O_3, antimony oxide, antimonious oxide, antimonious oxide, antimony trioxide, antimonious anhydride, "antimonious acid," antimony bloom, antimony ochre, flowers of antimony, white antimony, senarmontite, cervantite, stibiconate, valentinite. White, or grayish white, more or less cryst. powder; sometimes regular octahedra; turns yellow when heated, but becomes white again on cooling; melts at a dark red heat, and cryst. on cooling; volatilizes rapidly at c. 1550°; very sl. sol. in water; easily sol. in HCl; insol. in dil. HNO_3 and H_2SO_4; sol. in cold, fuming HNO_3 or H_2SO_4; sol. in $\text{HC}_2\text{H}_3\text{O}_2$ or $\text{H}_2\text{C}_2\text{H}_3\text{O}_2 + \text{Aq}$, and not pptd. from these solns. by water; sol. in $\text{SbCl}_3 + \text{Aq}$, $\text{NH}_4\text{Cl} + \text{Aq}$ or $\text{NH}_4\text{NO}_3 + \text{Aq}$; insol. in dil. but sol. in concd. $\text{NaOH} + \text{Aq}$ or $\text{KOH} + \text{Aq}$ and pptd. from these solns. on cooling; sol. in solns. of alkali carbonates; M. P. 656°; sp. gr. 5.7. Sb_2O_5, antimony oxide, antimonic oxide, antimony pentoxide, antimonic anhydride, "antimonic acid." Citron-yellow powder; sometimes white; insol. in water, but reddens moist, blue litmus paper; easily sol. in HCl; sl.	SnO, tin oxide, stannous oxide, tin monoxide. Small, black, lustrous, regular cryst., or brownish black powder; unchanged in air at ordinary temp; burns when heated in air, forming stannic oxide, SnO_2; insol. in water; sol. in acids to form stannous salts; insol. in NH_4OH; very sl. sol. in boiling $\text{NH}_4\text{Cl} + \text{Aq}$; insol. in dil. $\text{NaOH} + \text{Aq}$ or $\text{KOH} + \text{Aq}$; boiling with concd. $\text{NaOH} + \text{Aq}$ or $\text{KOH} + \text{Aq}$ gives a soln. of an alkali stannate and metallic Sn; sp. gr. 6.9.	SnO_2, tin oxide, stannic oxide, tin dioxide, flowers of tin, tin stone, cassiterite, tin ash, tin ore, putty powder. Hard, white, lustrous solid, quadratic cryst., trimetric cryst., or white to yellowish white, amorph. powder; hard enough to scratch glass; infusible; insol. in water; insol. in concd. acids, except H_2SO_4, which, when hot, dissolves it slowly; insol. in NH_4OH and concd. alkali solns.; fusion with NaOH or KOH gives an alkali stannate, which dissolves in water; sp. gr. 7.0. Sn_2O_3, (?) several compounds of varying compn., but with the general formula $x\text{SnO}$. $y\text{SnO}_2$ are said to exist.

Arsenic	Antimony	Tin(stannous)	Tin(stannic)	Oxide <i>Cont.</i>
melts under pressure; M. P. 275°; sp. gr. 3.7. As_2O_3, <i>arsenic oxide</i>, <i>arsenic pentoxide</i>, <i>arsenic anhydride</i>. White, glassy, deliq. solid, which slowly absorbs moisture from the air, forming arsenic acid, H_3AsO_4; slowly but completely sol. in water, forming H_3AsO_4; easily sol. in alcohol; much more sol. in alcohol than As_2O_3; heated above low redness it yields As_2O_3 and O_2; sp. gr. 4.	sol. in concd. $\text{KOH} + \text{Aq}$; loses oxygen at 300°, giving Sb_2O_3; sp. gr. 3.8. Sb_2O_3, <i>antimony tetroxide</i>. White powder, becoming yellow on heating; insol. in water; very sl. attacked by acids.			
AsPO_4, (?) <i>arsenic phosphate</i>. Of doubtful existence; insol. in water; sol. in acids.	SbPO_4, (?) <i>antimony phosphate</i>. Of doubtful existence; insol. in water; sol. in acids.	$\text{Sn}_3(\text{PO}_4)_2$, (?) <i>tin phosphate, stannous phosphate</i>. White, cryst. powder; insol. in water; sol. in mineral acids.	$2\text{SnO}_2 \cdot \text{P}_2\text{O}_5 \cdot 10\text{H}_2\text{O}$, <i>tin phosphate, stannic phosphate</i>. Octahedral cryst.; insol. in water or HNO_3.	Phosphate
Unknown.	Unknown.	SnHPO_3, <i>tin phosphite, stannous phosphite</i>. White powder that blackens on heating.	$\text{Sn}(\text{HPO}_3)_2$, <i>tin phosphite, stannic phosphite</i>. White powder or glassy masses.	Phosphite
Unknown.	Unknown.	Unknown.	$\text{Sn}(\text{SiO}_3)_2$, (?) <i>tin silicate</i>. Powder of variable compn.	Silicate
Unknown.	Unknown.	Unknown.	SnSiF_6, <i>tin silicofluoride, tin fluosilicate</i>. Very easily sol. in water.	Silicofluoride
$\text{As}_2(\text{SO}_4)_3$, (?) <i>arsenic sulfate</i>. Of doubtful existence; deliq. and decomp. by water.	$\text{Sb}_2(\text{SO}_4)_3$, <i>antimony sulfate, antimonous sulfate</i>. White powder or long, glistening, silky needles; very deliq.; sol. in acids; combines with water to a hard mass, with evolution of heat; with more water it becomes liquid, and by repeated treatment with much boiling water it is wholly de-	SnSO_4, <i>tin sulfate, stannous sulfate</i>. Small, heavy, white cryst.; tablets or needles; very sol. in water, but the soln. soon decomp., with separation of a basic salt; sol. in dil. H_2SO_4.	$\text{Sn}(\text{SO}_4)_2$, <i>tin sulfate, stannic sulfate</i>. White powder of doubtful compn., or white, rhombic leaflets; deliq. very easily; sol. in water, but decomp. by much water, with separation of SnO_2 and a basic salt; sol. in dil. H_2SO_4; slowly sol. in HCl; decomp. by absolute alcohol. SnOSO_4, <i>basic</i>	Sulfate

Sulfate
Cont.

Sulfide

Arsenic	Antimony	Tin(stannous)	Tin(stannic)
	comp. into H_2SO_4 and Sb_2O_3 .		<i>stannic sulfate.</i> Easily sol. in cold water, but quickly decomp., with separation of stannic hydroxide.
As_2S_3, <i>arsenic sulfide, arsenic disulfide, realgar, ruby sulfur, red orpiment, ruby arsenic, red arsenic, arsenic orange.</i> Occurs native as orange-red, somewhat translucent, monoclinic prisms or dark red powder, or amorph. masses, with resinous luster and conchoidal fracture; ignites at a high temp. and burns with a blue flame; when pure it is ruby color, easily fusible and cryst. after fusion; difficultly sol. in solns. of alkali sulfides; partly sol. in $\text{KOH} + \text{Aq}$ with decomp.; somewhat sol. in solns. of alkali carbonates; oxidized by HNO_3 to H_3AsO_4; M. P. 307°; sp. gr. 3.5. As_2S_5, <i>arsenic sulfide, arsenic trisulfide, arsenious sulfide, orpiment, yellow sulfide of arsenic, King's gold, King's yellow, red arsenic, royal yellow, Chinese yellow, Persian yellow, Spanish yellow.</i> Occurs native as lemon-yellow or sl. orange-yellow, translucent, trimetric prisms or lumps; pptd. as a lemon-yellow, amorph. powder that becomes darker when heated; melts easily at 300° and volatilizes at a higher	Sb_2S_3, <i>antimony sulfide, antimonious sulfide, antimony trisulfide, stibnite, antimony glance, Kermes mineral, red antimony, gray antimony, gray antimony ore, vitreous antimony, antimony black, antimony red, antimony sulfuret, crimson antimony, liver of antimony, antimonite, black antimony, Japanese antimony, antimony needles, iron black.</i> Occurs native as gray-black, trimetric, prismatic cryst. that melt easily; sometimes gray, metal-like masses, with striped cryst. fracture; pptd. as an orange or reddish brown, loose, amorph. powder; insol. in water, and dil. acids; sl. sol. in NH_4OH; very sl. sol. in $(\text{NH}_4)_2\text{CO}_3 + \text{Aq}$; sol. in concd. HCl, with formation of SbCl_3 and H_2S; decomp. by concd. H_2SO_4 to SO_2, S and $\text{Sb}_2(\text{SO}_4)_3$; decomp. by concd. HNO_3 to nitrate and sulfate of Sb mixed with S; aqua regia forms SbCl_3, H_2SO_4, and S; easily sol. in dil. $\text{KOH} + \text{Aq}$, $\text{NaOH} + \text{Aq}$, and yellow $(\text{NH}_4)_2\text{S}$; M. P. 550°; sp. gr. 4.6. <i>Colloidal Sb_2S_3.</i> Sol. in water; the soln. may be boil-	SnS, <i>tin sulfide, stannous sulfide, tin monosulfide.</i> Dark, lead-gray, cryst. solid; or gray, glistening scales; or thin, soft, friable, squares with gray-blue, metallic luster; or brownish black, amorph. powder; insol. in water; insol. in dil., sol. in concd. HCl, giving SnCl_2 and H_2S; sl. sol. in hot, concd. HNO_3, being oxidized to SnO_2; insol. in dil. acids; sol. with decomp. in concd. acids; insol. in $\text{KOH} + \text{Aq}$; sol. in solns. of alkali polysulfides; sol. in yellow $(\text{NH}_4)_2\text{S}$, from which HCl ppts. SnS_2; insol. in concd. $(\text{NH}_4)_2\text{CO}_3 + \text{Aq}$; gradually oxidized to SnO_2 and SO_2 when heated in air; M. P. 880°; sp. gr. 5.	SnS_2, <i>tin sulfide, stannic sulfide, tin disulfide, mosaic gold, artificial gold, tin bronze, cat's gold, mock gold, bronzing powder.</i> Soft, golden yellow, lustrous, cryst. solid; or yellow amorph. powder, or golden scales; insol. in water; insol. in dil. acids; amorph., but not cryst., SnS_2 is slowly decomp. by hot, concd. HCl to SnCl_4 and H_2S; amorph. SnS_2 is slowly oxidized by hot HNO_3; aqua regia oxidizes both forms to SnO_2 and H_2SO_4; sol. in hot $\text{KOH} + \text{Aq}$ or $\text{K}_2\text{CO}_3 + \text{Aq}$; sol. in alkali sulfide solns.; sol. in yellow $(\text{NH}_4)_2\text{S}$, but repptd. by HCl as SnS_2; insol. in concd. $(\text{NH}_4)_2\text{CO}_3 + \text{Aq}$; changes to SnO_2 and SO_2 when heated in air; sp. gr. 4.5.

Arsenic	Antimony	Tin(stannous)	Tin(stannic)	Sulfide Cont.
temp.; insol. in water when dry; when prepared moist it dissolves in water, giving colloidal As_2S_3; insol. in dil. acids; insol. in cold, scarcely attacked by hot concd. HCl, giving $AsCl_3$; easily decomp. by HNO_3 or aqua regia to H_3AsO_4; easily sol. in NH_4OH, and solns. of the alkali hydroxides and carbonates; sol. in yellow $(NH_4)_2S$, but reprecipitated by HCl; insol. in CS_2; sp. gr. 3.4. <i>Colloidal As_2S_3.</i> Sol. in water; the solution decomp. slowly on standing, but it may be boiled without precipitation of As_2S_3; most acids and many salts precipitate As_2S_3. As_2S_3, <i>arsenic sulfide, arsenic pentasulfide, arsenic persulfide</i>. Bright yellow, amorph. powder; easily fusible; may be sublimated in a stream of gas, which does not act on it; insol. in water; sol. in NH_4OH, $KOH + Aq$, $NaOH + Aq$ and solns. of alkali sulfides and carbonates.	ed without decomposition, but acids and salts reprecipitate Sb_2S_3. Sb_2S_3, <i>antimony sulfide, antimonious sulfide, antimony pentasulfide, antimony persulfide, golden antimony sulfide, golden sulfuret of antimony, golden sulfide of antimony, sulfur gold</i>. Fine, odorless, orange yellow, or dark orange, amorph. powder; insol. in water, or water containing H_2S; sol. in concd. HCl, giving $SbCl_3$ and H_2S; completely sol. in NH_4OH; easily and completely sol. in $NaOH + Aq$ or $KOH + Aq$; sol. in $Na_2CO_3 + Aq$ or $K_2CO_3 + Aq$; insol. or only very sl. sol. in $(NH_4)_2CO_3 + Aq$; easily sol. in solns. of alkali sulfides; sol. in yellow $(NH_4)_2S$, but reprecipitated by HCl; decomp. to Sb_2S_3 and S when heated out of contact with air. <i>Liver of antimony</i>. Impure double sulfides of Sb and alkali or alkaline earth metals.	Normal stannous sulfite unknown. $xSnO \cdot ySO_2 \cdot zH_2O$, <i>basic stannous sulfite</i>. Ppt.; insol. in water; partly sol. in $H_2SO_4 + Aq$; decomp. on boiling with water, with separation of SnO.	Stannic sulfite unknown. Unknown.	
Unknown.	$Sb_2(SO_3)_3$ (?) <i>antimony sulfite</i>. Of doubtful existence; insol. in water; sol. in acids.	Unknown. $Sb_2(C_2H_3O_2)_3$ (?) <i>antimony tartrate</i>. White, cryst. powder; insol. in wa-	Unknown.	Sulfite
Unknown.	Unknown.	$SnC_4H_7O_6$, <i>tin tartrate, stannous tartrate</i>. Heavy, white, cryst. pow-	Unknown.	

As, Sb, Sn GROUP

	Arsenic	Antimony	Tin(stannous)	Tin(stannic)
Tartrate Cont.		ter; sol. in acids. $2\text{SbOKC}_2\text{H}_3\text{O}_6$. H_2O , <i>antimony potassium tar- trate, tartar em- etic, tartrated an- timony</i> . Transpar- ent, odorless cryst. that turn white and opaque on standing; or fine, white powder; sweetish metallic taste; sol. in wa- ter; melts at 110° and loses cryst. water.	der; sol. in water and acids.	
Thio- cyanate	Unknown.	Unknown.	Unknown.	Unknown.
Thio- sulfate	Unknown.	Unknown.	SnS_2O_6 , (?) <i>tin thiosulfate, stan- nous thiosulfate, stannous hyposul- fite</i> . Known only in soln.	Unknown.
Tungstate	Unknown.	Unknown.	SnWO_6 , <i>tin tung- state, stannous tungstate, tin wol- framate</i> . Yellow ppt.; insol. in wa- ter; sol. in KOH + Aq or $\text{H}_2\text{C}_2\text{O}_4$ + Aq.	Unknown.

Note. In this table each acid is described in a manner similar to the treatment of salts in the preceding pages. Furthermore, directly following each acid is a condensed statement of the properties, solubilities and reactions of the salts of that acid taken as a class.

$\text{HC}_2\text{H}_3\text{O}_2$, acetic acid, pyroligneous acid, spirit of verdigris. Occurs in two forms, solid and liquid. The solid form, *glacial acetic acid, absolute acetic acid*, exists as prismatic or tabular cryst.; hygroscopic; pungent, sour taste and odor; blisters the skin; does not redden litmus paper of itself, but reddens it strongly when mixed with water; sp. gr. 1.06; M. P. 17° . Liquid acetic acid is transparent, colorless and mobile; mixes with water in all proportions; reddens blue litmus strongly; sp. gr. 1.05; B. P. 118° .

Acetates. Acetates of the alkali and alkaline earth metals are white; the rest are about evenly divided between white and colored; the normal acetates all dissolve in water, the most of them readily; the least sol. are the silver and mercury salts, so that solns. of other acetates added to mercurous nitrate or silver nitrate throw down white, shining scales of mercurous or silver acetate; acetates are not formed by pptn. but by the action of acetic acid on metallic oxides or carbonates; some carbonates, however, like those of barium and calcium, are not decomp. by concd. $\text{HC}_2\text{H}_3\text{O}_2$; all acetates are decomp. by heat, most of them yielding, among other things, CO_2 and acetone; the residue consists sometimes of the oxide of the metal, sometimes, as in the case of Cu and Ag, of the reduced metal; many acetates are decomp. by water into $\text{HC}_2\text{H}_3\text{O}_2$ and a metallic oxide.

H_3AsO_3 , arsenious acid. Known only as a soln. of As_2O_3 in water; this soln. has a sweetish metallic taste and a weak acid reaction.

Arsenites. The arsenites of the alkali and alkaline earth and of some of the other metals are white; the rest are colored; some are of doubtful existence or compn.; all arsenites, except those of the alkali metals, are partially or wholly insol. in water, but easily sol. in acids; several are sol. in NH_4 salt soln.; most arsenites are decomp. by heat, with formation of an arsenate and As; all basic arsenites are sol. in acids, except those that give an insol. salt with the bases; many are sol. in excess of $\text{As}_2\text{O}_3 + \text{Aq}$.

H_3AsO_4 , arsenic acid, orthoarsenic acid. Translucent cryst.; sol. in water with absorption of heat; aq. soln. tastes sour and metallic, it burns the skin; decomp. by HCl.

HAsO_4 , metarsenic acid. White, somewhat iridescent solid; slowly sol. in cold, quite easily in hot water, with considerable evolution of heat, and conversion into H_3AsO_4 .

$\text{H}_4\text{As}_2\text{O}_7$, pyroarsenic acid. Clear, lustrous cryst.; very deliq.; very easily sol. in water with evolution of much heat, and conversion into H_3AsO_4 .

Arsenates. The arsenates of the alkali and alkaline earth metals are white; the rest are colored; some are of doubtful existence or compn.; arsenates of the alkali metals, and acid arsenates of the alkaline-earth metals are sol. in water; neutral and basic arsenates are easily sol. in mineral acids including H_3AsO_4 , but less sol. in $\text{HC}_2\text{H}_3\text{O}_2$; the neutral alkaline-earth arsenates are less sol. in NH_4OH than in water, but more sol. in $\text{NH}_4\text{Cl} + \text{Aq}$.

H_3BO_3 , boric acid, boracic acid, orthoboric acid, Homburg's salt, sedative salt. White, semi-transparent laminae, or rhombic or monoclinic cryst.; sol. in water or alcohol; only sl. sol. in ether; volatile with steam; more sol. in dil. HCl than in water; sol. in warm, concd. H_2SO_4 , HCl or HNO_3 , but most of the boric acid separates on cooling; aq. soln. turns blue litmus paper wine-red, and turmeric paper cherry-red; alcoholic soln. burns with a green-edged flame; heated to 100° HBO_2 is formed; heated to 140° to 160° $\text{H}_2\text{B}_4\text{O}_7$ is formed; heated to c. 300° the oxide B_2O_3 remains.

HBO_2 , metaboric acid. White, glass-like, amorph. solid; sol. in water.

$\text{H}_2\text{B}_4\text{O}_7$, pyroboric acid, tetraboric acid. White, glass-like, amorph. solid; sol. in water.

Borates. Most borates are white; many are of doubtful compn.; a few are unknown; no borate is quite insol. in water; the alkali borates are very sol.; the less sol. borates are easily decomp. by water; the easily sol. borates are also decomp. but less quickly; a concd. aq. soln. of an alkali borate reddens but a dilute soln. blues litmus; the less sol. borates are easily sol. in $\text{H}_2\text{BO}_3 + \text{Aq}$, HNO_3 , etc., and they are more sol. in water containing $\text{H}_2\text{C}_2\text{H}_3\text{O}_2$ or $\text{K}_2\text{C}_2\text{H}_3\text{O}_2$ than in water; normal borates of the alkaline-earth metals are more sol. in hot than in cold

Acetic

Arsenious

Arsenic

Boric

Boric
Cont.

water; all borates are insol. or sl. sol. in alcohol; a few borates can be obtained as definite, fairly stable salts by pptn. from solns.; the more definite borates are generally obtained by melting together B_2O_3 and basic oxides; as a class borates decomp. readily; the compn. of many is, therefore, doubtful; solns. of alkali borates absorb CO_2 and H_2S ; few metallic salts of the form M_3BO_3 are known with certainty; most borates belong to the forms $M'BO_2$ and $M'_2B_4O_7$; most metallic borates are of the form $M'BO_2$.

Bromic

$HBrO_3$, bromic acid. Known only in aq. solns., as a colorless, acid liquid, with bromine-like odor; decomp. on standing; decomp. when heated in air, forming Br_2 , O_2 and H_2O ; not decomp. by dil. HNO_3 or H_2SO_4 ; decomp. by concd. H_2SO_4 ; decomp. by dil. HCl , forming H_2O and $BrCl$; oxidizable bodies decomp. $HBrO_3 + Aq.$ with separation of Br_2 ; alcohol and ether are quickly oxidized by $HBrO_3 + Aq.$

Bromates. The bromates cryst. well; most of them are white; a few are unknown; most of them are very sol. in water, a few are sl. sol. but none are insol.; the least sol. are $AgBrO_3$ and $HgBrO_3$; dil. HNO_3 , H_2SO_4 or $H_3PO_4 + Aq.$ decomp. bromates, giving $HBrO_3 + Aq.$ most of which decomp. to Br_2 , O_2 and H_2O ; bromates are decomp. by heat; sometimes O_2 is evolved and metallic bromide remains; sometimes Br_2 and O_2 are evolved, and the oxide remains; sometimes a mixture of bromide and oxide remains.

Hydro-
bromic

HBr , hydrobromic acid, hydrogen bromide, bromhydric acid. Colorless gas, with pungent, acid, very irritating odor; fumes in moist air; easily sol. in water; is absorbed by, and melts ice; liquefies at -73° and then cryst.; aq. soln. of HBr is colorless, strongly acid liquid; concd. aq. soln. fumes in, but is not decomp. by exposure to air; not decomp. by heat alone; decomp. by concd. HNO_3 or H_2SO_4 to Br_2 , H_2O and NO_2 or SO_2 ; an aq. soln. of HBr is decomp. by most metals, with formation of metallic bromides and H_2 .

Bromides. Most bromides are white; of the rest many are yellowish; most bromides are sol. in water, many in alcohol and some in ether; $AgBr$ and $HgBr$ are insol. in water or acids; $PbBr_2$ is sl. sol. therein; Cu_2Br_2 is insol. in water, sol. in acids; most metallic bromides are white, and generally isomorphous with the corresponding chlorides; most of them are not decomp. by heat alone, but some give up all their Br when heated; some metallic bromides are decomp. by water, others are decomp. when their aq. solns. are evaporated.

Carbonic

H_2CO_3 , carbonic acid. Known only as a soln. of CO_2 in water; unstable, decomp. by heat to H_2O and CO_2 ; aq. soln. is colorless, and turns blue litmus paper sl. red, but the blue color returns on exposure to air.

Carbonates. Most carbonates are white; a few are unknown; carbonates of Na , K , Rb and Cs are easily sol. in water; those of Li and Tl much less sol.; other carbonates are nearly or quite insol.; all carbonates are sol. to some extent in water containing CO_2 ; all carbonates, except those of NH_4 , Rb and Cs are insol. in alcohol; carbonates are generally decomp., with evolution of CO_2 , by those acids which are themselves sol. in water, except HCN and H_3BO_3 ; normal carbonates have the form M'_2CO_3 ; certain acid carbonates, $M'HCO_3$, have also been isolated, but very few of them have definite compn.; many basic carbonates exist; all carbonates, except those of the fixed alkalies, are wholly or partially decomp. by heat alone.

Chloric

$HClO_3$, chloric acid. Known only in aq. soln., which can be concd. only in a vacuum to a somewhat oily, colorless, strongly acid liquid; aq. soln. is colorless; it reddens blue litmus paper and then bleaches it; when heated to 40° the aq. soln. decomp. to $HClO_4 + Aq.$, Cl_2 , O_2 and H_2O .

Chlorates. Many chlorates are white; some are known only in soln.; a few are unknown; all chlorates, except mercurous chlorate, are sol. in water, $KClO_3$ less than the others; most of them are deliq.; many are sol. in alcohol; chlorates lose oxygen easily when heated, and are, therefore, good oxidizing agents; aq. solns. are not easily reduced; fusible chlorates detonate when rubbed with easily combustible substances, such as S ; sometimes violent explosions occur; decomp. by H_2SO_4 , with evolution of ClO_2 and Cl_2 ; decomp. by HCl ; aq. solns. of chlorates do not bleach; addition of a little $SO_2 + Aq.$ liberates Cl and bleaching occurs.

Hydro-
chloric

HCl , hydrochloric acid, hydrogen chloride, chlorhydric acid, muriatic acid, sol-dering acid, spirits of salt, marine acid, smoking salts. Colorless gas, with sharp, irritating odor; fumes in moist air; the dry gas does not redden litmus paper; has been condensed to a colorless liquid that freezes to a white, cryst. mass and is miscible with liquid CO_2 and H_2S ; the gas is absorbed by water, with production

of much heat; one volume of water dissolves 450 volumes of HCl gas at ordinary temp., but over 500 volumes at 0° and 760 mm. pressure; the aq. soln. is strongly acid; concd. HCl when heated gives off both HCl and H₂O till the temp. rises to 110° when a liquid of constant compn. 20% HCl and 80% H₂O distills over; gaseous HCl is not combustible; sol. in glacial HC₂H₃O₂ or ether; many metals decomp. gaseous HCl when heated in it, giving chlorides and H₂; aq. soln. of HCl is decomp. by many metals, with formation of chlorides and H₂; HCl+Aq evolves a little Cl₂ when exposed to air and sunlight; concd. HCl and concd. HNO₃ mix to a yellow liquid, called *aqua regia*; this evolves nascent Cl; HNO₃+3HCl=2H₂O+NOCl+2Cl; aqua regia attacks metals, forming chlorides.

Chlorides. Chlorides of the alkali and alkaline earth metals are white; many of the others are colored; many contain water of crystallization; most chlorides are sol. in water; a few, however, are insol. or nearly so therein, the chief of which are AgCl, HgCl, CuCl, PtCl₂ and AuCl; also PbCl₂ in the cold; several chlorides are decomp. into insol. oxychlorides or hydroxides or oxides, either by addition of water, as in the case of BiCl₃ and SbCl₃, or on evaporating the aq. soln. as AlCl₃, ZnCl₂, MgCl₂, etc.; some chlorides are sol. in alcohol or ether; most metallic chlorides may be vaporized without decomp.; some yield lower chlorides on heating; a few are completely decomp. into Cl and the metal; most metallic chlorides are unchanged when heated in dry air, but many are decomp. when heated in moist air; aq. acids decomp. metallic chlorides, forming HCl, or in the cases of easily reducible acids, e.g. HNO₃, evolving chlorine; a few oxychlorides are known; many double chlorides exist.

H₂CrO₄, chromic acid. Known only in aq. soln., made by dissolving chromic anhydride, CrO₃, in water.

Chromic

Chromates. Chromates are mostly yellow or red; chromates of the alkali metals, and of Ca, Mg and Sr, are easily sol. in water; the others are generally insol. or sl. sol. in water, but sol. in HNO₃; solns. of chromates have a metallic taste; insol. chromates yield alkali chromates by fusion with KOH or NaOH; normal chromates have the form M₂CrO₄; some basic and double chromates are known; aq. solns. of alkali chromates turn from yellow to red on addition of an acid from formation of a dichromate, M₂Cr₂O₇; the addition of an alkali restores the yellow color.

Dichromates. Dichromates are mostly yellow or red, a little deeper in color than the corresponding chromates; most of these are sol. in water; many of them are decomp. by water; they are generally redder or deeper in color than the corresponding chromates.

HCN, hydrocyanic acid, prussic acid, hydrogen cyanide, cyanhydric acid, formonitrile. Mobile, colorless liquid, with peculiar, very penetrating odor; does not redden litmus; intensely poisonous, one drop of the anhydrous acid being fatal if swallowed; the vapor, even if mixed with air, is poisonous; miscible with water, alcohol and ether, with absorption of heat; is a very weak acid; burns in air with blue flame; HCN or HCN+Aq is unstable in air, brown, humus-like products being formed; concd. mineral acids produce formic acid and NH₃.

Hydro-
cyanic

Cyanides. Most cyanides are white; a few contain water of crystallization; several are unknown; the alkali cyanides are easily sol. in water; those of the alkaline-earth metals are less sol., while all other are insol., with the exception of Hg(CN)₂; all cyanides are sol. in KCN+Aq, generally with formation of double cyanides; alkali cyanides are very easily decomp., with evolution of HCN, a current of air free from CO₂ being sufficient to effect the change; some of the insol. cyanides are readily decomp. by dil. acids, others are very stable toward acids; hot, concd. H₂SO₄ decomp. all cyanides, some easily, others slowly, the products being a sulfate and HCN or CO and NH₃; alkali cyanides are unchanged by heat alone; cyanides of the heavy metal are decomp. by heat, generally forming the metal and (CN)₂, sometimes N₂ is evolved and C deposited on the metal, or a carbide of the metal is formed.

H₂Fe(CN)₆, hydroferrocyanic acid, ferrocyanic acid, ferroprussic acid, hydrogen ferrocyanide, ferrocyanhydric acid. White cryst. powder; becomes blue in moist air, with evolution of HCN and formation of Prussian blue, Fe₄[Fe(CN)₆]₃; sol. in water and alcohol; insol. in ether; much less sol. in ether-alcohol than in alcohol; aq. soln. is strongly acid to litmus; it decomp. carbonates, acetates, tartrates and oxalates; when boiled with water it is decomp. to HCN and white FeH₂Fe(CN)₆; insol. in concd. HCl.

Hydrofer-
rocyanic

Ferrocyanides or ferroprussiates. Nearly all ferrocyanides are colored; the

ACIDS

Hydroferrocyanic Cont.

ferrocyanides of the alkali and alkaline-earth metals are sol. in water; the others are insol., but sol. in solns. of alkalis in case the base is sol. therein; many ferrocyanides are colored; the soluble alkali ferrocyanides are not poisonous; those ferrocyanides which are completely dehydrated by heat without decomp. are decomp. at higher temp. into N and Fe carbide, and either a cyanide of the other metal, or N and metallic carbide; those ferrocyanides which cannot be completely dehydrated, without decomp., are resolved at a high temp. into HCN, CO, NH₃ and either a mixture or compound of each of the metals with C; heated with concd. H₂SO₄, ferrocyanides give SO₂, CO, CO₂ and N₂, and form sulfates of NH₄, Fe and the other metal of the original salt; some ferrocyanides are decomp. by H₂S, giving metallic sulfides and ferrocyanhydric acid; ferrocyanides of heavy metals are generally decomp. by aq. alkalis, giving alkali ferrocyanides and a ppt. of the hydroxide of the heavy metal.

Hydroferricyanic

H.Fe(CN)₆, hydroferricyanic acid, ferricyanic acid, ferriprussic acid, hydrogen ferricyanide, ferricyanhydric acid. Lustrous, brownish-green needles; very sol. in water and alcohol; soln. decomp. slowly on standing; more rapidly by heating, the products being HCN and a blue residue; insol. in ether.

Ferricyanides or ferriprussiates. Nearly all ferricyanides are colored; alkali and alkaline-earth ferricyanides are sol. in water; most of the other ferricyanides are insol. and may be formed by pptn. by addition of an alkali ferricyanide to metallic salt solns.; the ferricyanides of metals, the oxides of which are sol. in NH₄OH, or KOH+Aq. are themselves sol. in those reagents.

Hydrofluoric

HF, hydrofluoric acid, hydrogen fluoride, fluorhydric acid. Colorless, very mobile liquid; fumes strongly in air and absorbs water very rapidly; burns and inflames the skin; vapor is irritating and poisonous; solidifies at -102° and liquefies again at -92°; very sol. in water, with evolution of much heat; the concd., aq. soln. of HF is a colorless, strongly acid liquid, which fumes in the air; does not attack gutta-percha or paraffine; decomp. silica, SiO₂, and silicates rapidly, with evolution of gaseous SiF₄; if much water is present the SiF₄ reacts with it, forming hydrofluosilicic acid, H₂SiF₆; aq. soln. of HF reacts with metals, similarly to HCl+Aq, evolving H₂ and forming fluorides.

Fluorides. The majority of fluorides are white; metallic fluorides are generally easily fusible solids, similar to, and as a rule, isomorphous with, the chlorides; metallic fluorides are generally insol. in water; the alkali fluorides, also AgF and SnF₂, are sol. in water; fluorides of Fe, Sr and Cd are sl. sol.; the others are insol. in water; the fluorides of Bi and Sb are not decomp. by water, whereas BiCl₃ and SbCl₃ are immediately decomp. thereby; most fluorides are sol. in acids, especially in HF+Aq, forming, probably, acid salts, aq. solns. of which turn blue litmus paper red and etch glass; these acid salts are decomp. by heat, with evolution of HF; most metallic fluorides are very stable and not decomp. by heat; decomp. by hot, concd. H₂SO₄; fluorides, as a class, combine together to form double fluorides; alkali metal fluorides show great tendency to unite with other metallic fluorides; these double fluorides are generally more stable than the corresponding double chlorides, bromides and iodides.

Hydroxide:

Hydroxides. Compounds wherein the hydroxyl group, OH, is united to a metal are called hydroxides; they were formerly, though incorrectly, called hydrates, which term is now reserved for those compounds which contain water of hydration; sometimes they are called bases; alkali metal hydroxides are generally white, strongly alkaline, and sol. in water; alkaline-earth hydroxides are white, sl. alkaline, and sl. sol. in water; other metallic hydroxides are neutral, insol. in water, and sometimes white but more often colored; the insol. hydroxides may be made by pptn. from an alkali hydroxide and metallic salt solns.; all hydroxides are sol. in acids, with formation of water and metallic salts; the insol. hydroxides are more or less decomp. by heat into water and the oxide of the metal.

Hypo-chlorous

HClO, hypochlorous acid. Known only in aq. soln., which smells like Cl₂O or bleaching powder; very easily decomp., even at 0°, into Cl₂ and HClO₂; heat or sunlight hastens the decomp.; concd. soln. decomp. more rapidly than dil.; concd. HClO₂+Aq is yellowish and decomp. when distilled; dil. HClO₂+Aq is less easily decomp. when distilled; strong oxidizer and bleacher of vegetable fibers; HCl evolves Cl₂ from the aq. soln.; does not dissolve insol. oxides, hydroxides or carbonates

Hypochlorites. Many hypochlorites are unknown; those known are unstable compounds and often found only in soln.; decomp. by acids, even by H₂CO₃; aq. solns. of hypochlorites are slowly converted into the chloride and chlorate on

standing, more rapidly when heated in absence of free alkali; O_2 is often evolved in this reaction; sol. hypochlorites are caustic and have a sweetish, disagreeable smell.

H_3PO_2 , *hypophosphorous acid*. Large, white, cryst. tablets; melts at 17.4° ; very sol. in water and alcohol; $H_3PO_2 + Aq$ is an energetic reducing agent; decomp. by heat to PH_3 and H_2PO_4 ; decomp. by hot, concd. H_2SO_4 to H_2PO_4 , SO_2 and S.

Hypophosphites. Many hypophosphites are unknown; of those known, many are white; nearly all the hypophosphites are sol. in water; some are deliq.; they are decomp. by heat, evolving PH_3 and H_2 , and generally leaving pyro- and metaphosphates.

HIO_3 , *iodic acid*. Colorless, trimetric cryst.; very sol. in water and alcohol; insol. in abs. alcohol; an active oxidizing agent; all metals except the Pt metals and Au are oxidized by $HIO_3 + Aq$; H_2SO_3 is oxidized to H_2SO_4 ; H_2S is decomp. to HI and S; the lower oxides of N are oxidized to HNO_3 ; HCl forms ICl_3 and Cl_2 .

Iodates. The majority of the iodates are whites; many have water of crystallization; the alkali iodates are sol. in water; the others are sl. sol. or insol. therein; easily decomp. by heat, generally giving a mixture of metallic iodide and oxide, sometimes I_2 alone; solutions of iodates are more easily reduced than chlorates; $KIO_3 + Aq$ may be reduced by $SO_2 + Aq$ or $H_2S + Aq$; with HI + Aq iodates give I_2 and metallic iodides; with HCl they give ICl_3 , Cl_2 , H_2O and metallic chloride; dil. H_2SO_4 produces HIO_3 .

HI, *hydriodic acid, hydrogen iodide, iodhydric acid*. Colorless, strongly acid gas; incombustible; extinguishes flame; readily liquefied to a colorless or yellowish liquid that solidifies at -55° to a colorless, ice-like mass; very easily and quickly absorbed by water, with evolution of much heat; HI + Aq is a colorless, strongly acid, fuming liquid that decomp. on exposure to air, with separation of I_2 ; concd. HNO_3 decomp. gaseous HI instantaneously; concd. H_2SO_4 forms I_2 , also SO_2 and H_2S ; many metals with HI + Aq form iodides and evolve H_2 .

Iodides. Iodides of the alkali and alkaline-earth metals are white; many of the others are colored; many have water of crystallization; the iodides are in general easily sol. in water; exceptions are HgI_2 , PbI_2 , AgI , CuI_2 , BiI_3 , and the iodides of the Pt metals, all of which are insol.; SnI_4 , SbI_3 and TlI_3 are decomp. by water; many iodides are more sol. in solns. of salts than in water; several are sol. in alcohol or ether; metallic iodides are usually less easily decomp. by water than the corresponding bromides and chlorides; metallic iodides are, in general, not so volatile as chlorides or bromides; most of them are unchanged by heat, but some are decomp. to metal and I_2 ; many metallic iodides dissolve freely in solns. of the alkali iodides, frequently with formation of double iodides.

H_2MnO_4 , *manganic acid*. Known only in soln., which decomp. rapidly to $HMnO_4$ and MnO_2 .

$HMnO_4$, *permanganic acid*. Known only in soln., which decomp. by evaporating or warming to MnO_2 and O_2 .

Manganates. Many of the manganates are unknown; nearly all the rest are colored; K_2MnO_4 and Na_2MnO_4 are sol. in water or aqueous alkali soln. without decomp.; other manganates that are known are either insol. in water or decomp. thereby; aq. soln. of the alkali manganates are decolorized, with pptn. of MnO_2 , by easily oxidized bodies, e. g. $SO_2 + Aq$ and $H_2S + Aq$; manganates are isomorphous with sulfates.

Permanganates. Permanganates of the alkali and alkaline-earth metals are the best known; many of the others are unknown; all permanganates are sol. in water, except $AgMnO_4$, which is sl. sol.; they are purple red in color and isomorphous with perchlorates; solns. of permanganates are decomp. by NH_4OH ; they are reduced to manganous salts by HNO_3 , concd. HCl or $SO_2 + Aq$; H_2SO_4 decomp. solid permanganates with separation of MnO_2 and evolution of O_2 .

H_2MoO_4 , *molybdic acid*. Minute needle-like cryst.; insol. or nearly so in water.

Molybdates. Many molybdates are white; a few are unknown; the normal molybdates of the alkali metals are easily sol. in water; the others are sl. sol. or insol. therein; many dimolybdates and trimolybdates are known; these are, in general, more easily sol. in water than the ordinary molybdates.

HNO_3 , *nitric acid, hydrogen nitrate, spirit of niter, azotic acid*, and when dil. with water, *aqua fortis*. Colorless, highly corrosive liquid; solidifies at c. -47° ; boils at 86° , but begins to decomp. below this temp.; at c. 256° decomp. completely

Hypo-
chlorous
Cont.

Hypophos-
phorous

Iodic

Hydriodic

Manganic

Molybdic

Nitric

ACIDS

Nitric Cont.

into NO_2 , H_2O and O_2 ; slowly and partially decomp. by sunlight, giving NO_2 , O_2 and H_2O , so that when exposed to sunlight it becomes yellow and contains NO_2 ; miscible with water; when concd. HNO_3 is diluted with water heat is produced; HNO_3 is reduced by many metals; the products vary with the temp., concentration of the acid, and nature of the metal; only Mg evolves H_2 ; the gaseous products from other metals are generally N_2O , NO and N_2 ; in most cases nitrates of the metals are formed but sometimes these are decomp. to metallic oxides; HNO_3 , with HCl , forms *aqua regia*, but for this see HCl .

$2\text{HNO}_3 \cdot \text{N}_2\text{O}_5$ or $\text{H}_2\text{N}_2\text{O}_5$, *fuming nitric acid, dinitric acid*. Bluish yellow liquid; fumes in air; solidifies at c. 5° ; evolves N_2O_5 when warmed gently; is a powerful oxidizing agent; miscible with water, with evolution of much heat; when diluted with water the liquid turns green, then blue, and finally colorless when very dil.; red NO_2 vapors are evolved, the rapidity increasing with the temp.

Nitrates. Nitrates of Cr, Fe, Co, Ni and Cu are colored; the rest are white; many have water of crystallization; all nitrates are sol. in water, except a few basic salts; most nitrates are insol. in concd. HNO_3 , but dissolve on dilution with water; many nitrates are sol. in alcohol; most nitrates are cryst. salts; none have been vaporized; nitrates are decomp. by heat; a few give off HNO_3 , but in almost all cases O_2 and N oxides are evolved and metallic oxides are left; heated with combustible bodies, nitrates cause deflagration or explosion.

Nitrous

HNO_2 , *nitrous acid*. Known only in aq. soln., which probably contains HNO_2 as well as HNO_3 .

Nitrites. Nitrites are usually white or yellow; some are known only in soln., several are unknown; normal nitrites, except AgNO_2 , are sol. in water and alcohol; but, as a rule, they are less sol. than the corresponding nitrates; several basic salts are known; nitrites are decomp. by heat, evolving NO or NO_2 , and leaving metallic oxide or metal; solns. of nitrites are decomp. by boiling, generally with evolution of NO and formation of nitrates; nitrites in soln. are decomp. by dil. H_2SO_4 , giving HNO_2 which soon decomp. to HNO_3 and NO .

Oxalic

$\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$, *oxalic acid*. Large, monoclinic cryst.; easily sol. in water and alcohol; gives off its cryst. water at 100° ; at 150° part sublimates and part decomp. to H_2O , CO and CO_2 ; aq. soln. decomp. slowly in light; hot, concd. H_2SO_4 decomp. it to H_2O , CO and CO_2 ; hot HNO_3 oxidizes it to CO_2 .

Oxalates. The prevailing color of oxalates is white; alkali metal oxalates are sol. in water; other oxalates are insol. or only sl. sol.; a few acid oxalates are known.

Oxides

Oxides. The oxides are generally amorph. powders; those of the alkali metals dissolve in water to form alkaline hydroxides; those of the alkaline-earth metals attract moisture slowly from the air to form hydroxides; the other metallic oxides are generally stable; many metallic oxides are colored; the rest are white; most metallic oxides dissolve in mineral acids to form water and metallic salts; oxides of the non-metallic substances will be taken up under the separate non-metallic elements.

Phos- phoric

H_3PO_4 , *phosphoric acid, orthophosphoric acid*. Thick, semi-solid mass or cryst. tablets; melts at c. 42° and solidifies at 38° , with a rise of temp. to 40.5° ; deliq.; readily sol. in water; miscible with concd. $\text{H}_2\text{C}_2\text{O}_4$; forms $\text{H}_2\text{P}_2\text{O}_7$ when heated to c. 213° ; at higher temp. HPO_3 begins to be formed, and at full red heat only HPO_3 is produced.

HPO_3 , *phosphoric acid, metaphosphoric acid*. Soft, silky masses, or hard, transparent, colorless, glass-like solid; very hygroscopic and deliq.; completely volatile at bright red heat. Glacial phosphoric acid is hexametaphosphoric acid, $\text{H}_6\text{P}_6\text{O}_{18}$, or impure HPO_3 ; deliq.; easily sol. in water, with evolution of heat and conversion into H_3PO_4 .

$\text{H}_2\text{P}_2\text{O}_7$, *phosphoric acid, pyrophosphoric acid*. Glass-like solid, or opaque cryst.; readily sol. in water; the soln. may be kept without change, but on heating it is converted into H_3PO_4 .

Phosphates. The phosphates of the alkali and alkaline-earth metals are white; many of the others are also white; the phosphates of NH_4 , K, Na, Li, Cs and Rb, are sol. in water, with the exception of certain metaphosphates; the other phosphates, except neutral Tl salts, are nearly insol. in water, excepting when an excess of H_3PO_4 is present; the latter are all sol. in HNO_3 .

Orthophosphates. Tertiary orthophosphates are generally known; a few secondary salts are unknown; more of the primary salts are unknown; K, Na, Li, Cs and Rb orthophosphates are sol. in water, generally with alkaline reaction; all

the others are insol. in water, but sol. in excess of $\text{H}_3\text{PO}_4 + \text{Aq}$ and HNO_3 ; less easily sol. in $\text{HC}_2\text{H}_3\text{O}_2$; Pb, Al and ferric phosphates are insol. in $\text{HC}_2\text{H}_3\text{O}_2$; orthophosphates are sl. sol. in solns. of NH_4 salts, especially $\text{NH}_4\text{Cl} + \text{Aq}$, from which soln. they are pptd. by NH_4OH ; orthophosphates insol. in water are also insol. in excess of alkali orthophosphate soln.; all orthophosphates are insol. or very sl. sol. in alcohol; all are decomp. by H_2SO_4 .

Metaphosphates. Most metaphosphates are definitely known; some are sol. in water, the others are insol.; aq. solns. are changed to orthophosphates on long boiling.

Pyrophosphates. Most pyrophosphates are definitely known; normal alkali pyrophosphates are sol. in water with feebly alkaline reaction; the others are insol. in water, but are mostly sol. in an excess of $\text{Na}_4\text{P}_2\text{O}_7 + \text{Aq}$, forming double salts; aq. solns. of pyrophosphates give orthophosphates when boiled with the stronger acids.

Phos-
phoric
Cont.

H_3PO_3 , *phosphorus acid*. Colorless, cryst. mass or transparent cryst.; melts at 74° ; at higher temp. decomp. to H_2PO_4 and PH_3 ; very deliq.; very sol. in water; oxidizes slowly in air to H_3PO_4 ; oxidized by HNO_3 to H_3PO_4 .

Phosphites. Normal phosphites are generally known; acid phosphites of the alkali metals are better known than those of the other metals; the neutral alkali phosphites are sol. in water; most of the others are insol. or sl. sol. in water, but sol. in $\text{H}_2\text{PO}_3 + \text{Aq}$; all are insol. in alcohol; decomp. by heat, generally giving off H_2 or PH_3 , and leaving pyrophosphate and phosphide; aq. solns. of phosphites are fairly stable in air, but are easily oxidized to phosphates by oxidizing agents.

Phos-
phorous

$\text{SiO}_2 \cdot x\text{H}_2\text{O}$, *silicic acid*. The exact compn. of silicic acid is doubtful, for the acid cannot be isolated with certainty; reactions that theoretically should give silicic acid give a gelatinous ppt. insol. or sl. sol. in water, more sol. in acids, and easily decomp. to SiO_2 and H_2O ; a colloidal form is known, sol. in water.

H_2SiO_3 , *silicic acid, metasilicic acid*. Has not been isolated with certainty; transparent, glassy, lustrous solid; insol. in water.

H_4SiO_4 , *silicic acid, orthosilicic acid*. Has not been isolated with certainty; clear liquid or transparent, colorless jelly; insol. in water; decomp. to H_2SiO_3 when dried.

Silicates. The silicates of the alkali and alkaline-earth metals are white; many of the others are colored; some are derived from orthosilicic acid and some from metasilicic acid; the silicates are insol. in water, with the exception of the alkali salts, and these are sol. only when the ratio of the base to the acid is above a certain limit; very many silicates occur native, and many of these contain several bases.

Silicic

H_2SiF_6 , *fluosilicic acid, hydrofluosilicic acid, silico-fluorhydric acid*. Known mostly in aq. soln.; a strongly acid liquid, smelling like HCl , and burning the skin; decomp. by concd. H_2SO_4 or HCl gas, with formation of SiF_4 and H_2O ; aq. soln. decomp. to HF and SiF_4 on evaporation.

Silicofluorides or fluosilicates. Silicofluorides of the alkali and alkaline-earth metals are white; many of the others are white or colorless; a few are unknown; most of the silicofluorides are sol. in water; the salts of Ba, K, Na and Ce are only sl. sol. in water and insol. in alcohol; aq. solns. of silicofluorides reddens litmus paper; silicofluorides are generally decomp. by heat, giving off SiF_4 and leaving fluorides; concd. H_2SO_4 evolves H_2SiF_6 ; when heated, HF is given off; concd. HCl and HNO_3 react similarly, but more slowly and less completely.

Fluosilicic

H_2SO_4 , *sulfuric acid, hydrogen sulfate, oil of vitriol, vitriol, dipping acid, electrolytic acid, pickling acid, elixir of vitriol, brimstone acid, chamber acid, dipping oil, spirit of vitriol*. Clear, colorless, oily, hygroscopic liquid; solidifies at c. 10.5° ; may be cooled much below its freezing point without solidifying; but addition of a crystal of H_2SO_4 or a little SO_3 causes cryst.; the presence of a trace of water lowers the freezing point to c. 0° ; strongly acid; irritates and burns the skin; fumes very sl. in air at ordinary temp., but more at $30-40^\circ$, giving off SO_3 ; has no definite boiling point, for it decomp. when heated; boiling begins at c. 290° , and the temp. rises gradually to 338° , where dissociation to H_2O and SO_3 is complete; sol. in water in all proportions, with evolution of much heat and with slight contraction of volume; reacts with most metals, evolving generally H_2 , sometimes SO_2 or H_2S , with occasional separation of S; reacts with most salts to form sulfates, and sets free the acid of the salt if that acid is more volatile than H_2SO_4 ; decomp. many salts rich in oxygen with evolution of O_2 .

$\text{H}_2\text{S}_2\text{O}_7$, *disulfuric acid, pyrosulfuric acid, fuming sulfuric acid, Nordhansen sulfuric acid, oleum*. Large cryst., melting at 35° , and decomp. easily into H_2SO_4 and

Sulfuric

ACIDS

Sulfuric Cont.

SO₃; usually found as an oily liquid that fumes strongly in air and gives off SO₂ when heated; similar to, but more active than, ordinary sulfuric acid.

Sulfates. The sulfates of Cr, Fe, Co, Mn and Cu are colored, the rest are white; many have water of crystallization; most sulfates are sol. in water; but Ag₂SO₄, Hg₂SO₄ and CaSO₄ are only sl. sol., while BaSO₄, SrSO₄ and PbSO₄ are nearly insol. therein; all sulfates are sol. in concd. H₂SO₄; basic sulfates are insol. in water; most sulfates are insol. in alcohol; normal, acid, basic and double sulfates are all known; sulfates of the alkali and alkaline-earth metals are not decomp. by heat alone; sulfates of other metals are decomp. by heating, giving off SO₃, or SO₂ and O₂, and leaving metallic oxides, or metals if the oxides are reducible by heat.

Hydrogen Sulfide

H₂S, *hydrogen sulfide, sulfuretted hydrogen, sulfydric acid, hydrosulfuric acid.* Colorless gas with offensive, rotten-egg odor; sol. in c. one-third its volume of water; more sol. in alcohol; liquefied by pressure and cold to a very mobile, transparent, refractive liquid that is a little lighter than water, boils at -62°, and solidifies at -86°; gaseous H₂S burns easily in air with a blue flame to SO₂ and H₂O, some S separating if air is not in excess; decomp. to H₂ and S on passing through a hot tube at 400°; H₂S+Ag decomp. on exposure to air, with separation of S; soln. keeps best in a corked bottle inverted under water; decomp. by many metals, when heated therewith, metallic sulfides and H₂ being formed; difficultly sol. in concd. H₂SO₄ with decomp.; instantly decomp. by fuming HNO₃.

H₂S₂, *hydrogen persulfide.* Decomp. easily.

Sulfides. The sulfides of Ba, Sr, and Zn are white; the rest are usually colored; the sulfides of the alkali metals are sol. in water; those of the alkaline-earth metals are much less sol., and are decomp. upon soln. into hydrosulfide and hydroxide; the other sulfides are insol., or only very sl. sol. in water; very dil. aq. solns. of several metallic sulfides in the colloidal form are known; metallic sulfides are decomp. by strong acids, giving salts and H₂S; secondary reactions frequently occur, S almost always separating; several sulfides sublime out of contact with air; all are oxidized by heating to redness in air; the sulfides of the very positive metals yield sulfates, those of the heavy metals generally form metallic oxides,—occasionally the metal itself,—and give off SO₂; many metallic sulfides are decomp. by water, at different temp., giving oxides or hydroxides and H₂S.

Persulfides. Several are known.

Sulfurous

H₂SO₃, *sulfurous acid, hydrogen sulfite.* Known only as an aq. soln. of SO₂; this decomp. easily on standing or warming, yielding SO₂; a little H₂SO₃ is sometimes formed during the decomp.; is oxidized to H₂SO₄ by O₂, the halogens, and oxidizing agents; many metals which evolve H₂ from H₂SO₄ or HCl react with H₂SO₃+Aq to form sulfites and sulfides, with evolution of little or no H₂; many metallic salts are reduced, in aq. soln., by H₂SO₃+Aq.

Sulfites. The sulfites of the alkali, the alkaline-earth, and a few other metals are white; a few basic salts are known; of the acid salts those of the alkali metals are best known; all acid sulfites are insol. in water; of the normal sulfites only the alkali sulfites are sol. in water, and they are insol. or only sl. sol. in alcohol; sulfites in aq. soln., and many in moist air, oxidize readily to sulfates, but sometimes salts of other S oxyacids are formed, and frequently S separates; easily oxidized to sulfates by oxidizing agents; decomp. at red heat to sulfides and sulfates, or to oxides and SO₂; decomp. by most all acids, but not by H₂CO₃+Aq or boric acid, giving off SO₂.

Tartaric

H₂C₄H₄O₆, *tartaric acid.* Monoclinic prisms, with hemihedral facets; is dextro-rotary, the rotation depending on the concentration of the soln. and the presence of impurities; melts at 170°; very readily sol. in water, less in alcohol; insol. in ether; when heated above its melting point, it loses water and yields various anhydrides according to amount of heat; at higher heat it turns brown, with production of a caramel-like odor; at still higher temp. it chars, yielding other organic acids.

Tartrates. The prevailing color of tartrates is white; alkali tartrates are sol. in water; alkaline-earth tartrates are sl. sol.; the solubility of other tartrates varies considerably, but they are generally insol. or sl. sol.; a few acid tartrates are known; tartrates are decomp. by heat, giving a burnt sugar odor.

Thio- cyanic

HSCN, *thiocyanic acid, sulfocyanic acid, hydro-sulfocyanic acid, sulfocyanhydric acid.* Colorless, strongly smelling, very acid liquid, that cryst. a little below 0°; sol. in water; stable in dil. aq. soln.; otherwise decomp. by heat, by H₂S, or by mineral acids yielding various CN compounds.

Thiocyanates, sometimes called **sulfocyanates** or **sulfocyanides**, and originally

called **rhodonides**. The prevailing color of thiocyanates is white; most thiocyanates are sol. in water; Cu, Pb, Hg and Ag thiocyanates are insol.; decomp. when heated in air, yielding either metallic sulfides or sulfates.

$\text{H}_2\text{S}_2\text{O}_3$, *thiosulfuric acid*, formerly called *hyposulfurous acid*. Known only in aq. soln., which is very unstable, and decomp. very easily and quickly to $\text{H}_2\text{SO}_3 + \text{Aq}$ and S.

Thiosulfates. A few thiosulfates are unknown; some are known only in soln. or as double salts; formerly and incorrectly called **hyposulfites**. The thiosulfates of the alkalis and of Ca and Sr are easily sol. in water; many of the others are insol. or only sl. sol.; salts of the metals are sol. in alkali thiosulfate solns.; all are insol. in alcohol; thiosulfates are decomp. by strong heat; alkali salts leave a mixture of sulfate and sulfide; other salts also give off H_2S and S; aq. solns. of thiosulfates evolve H_2S when boiled, forming sulfates, or sulfides if the metal of the thiosulfate is pptd. by H_2S ; aq. solns. of thiosulfates are decomp. by dil. mineral acids, with separation of S and evolution of SO_2 , and formation of salts of the acid used.

H_2WO_4 , *tungstic acid*, *orthotungstic acid*. Yellow solid that reddens litmus; insol., or nearly so in water; sol. in HF, insol. in tungstate solns.

$\text{H}_2\text{W}_2\text{O}_{13}$, *metatungstic acid*. Sulfur yellow octahedra; easily sol. in water to a very sour, bitter liquid that may be boiled and evaporated to a syrupy consistency, when it suddenly gelatinizes and ordinary tungstic acid is pptd.

Tungstates. The tungstates of the alkali and alkaline-earth metals are white; most of the rest are colored; many tungstates have been made, but their compn. varies considerably; the best known are the orthotungstates and the metatungstates; few normal tungstates or orthotungstates are sol. in water, the alkali salts being only sl. sol.; most of the metatungstates are easily sol. in water and cryst. therefrom; tungstates insol. in water are usually insol. in dil. acids; solns. of alkali orthotungstates give ppts. of yellow $\text{WO}_3 \cdot \text{H}_2\text{O}$ or white $\text{WO}_3 \cdot 2\text{H}_2\text{O}$, with dil. H_2SO_4 , HCl , HNO_3 or $\text{H}_3\text{PO}_4 + \text{Aq}$; aq. solns. of metatungstates are not pptd. by cold acids except on long standing or boiling; metatungstates are changed to orthosalts by excess of alkali; when strongly heated, orthotungstates are formed; solns. of metatungstates are not pptd. by H_2S .

**Thio-
cyanic**
Cont.

**Thio-
sulfuric**

Tungstic

The following list contains the properties of the non-metals and of those metals that have not been described in the preceding pages.

To these non-metals and rare metals are added their bromides, carbonates, chlorides, hydroxides, nitrates, oxides, sulfates, and sulfides when such are known.

Ac, actinium. A very rare and unstable element; has not yet been isolated from the rare earths; resembles the trivalent elements of the cerium group, especially La; trivalent element, isotopic with mesothorium II; not volatile at red heat; breaks down slowly but at a definite rate into disintegration products; the Ac emanation is sl. sol. in water, a little less so in concd. H_2SO_4 ; At. No. 89; At. Wt. (?); M. P. (1800°); B. P. > 1700°.

Actinium

Ac compounds are not described in much detail; the *hydroxide* is said to be gelatinous, sl. more basic than lanthanum hydroxide; the *salts* are said to be colorless, similar to the corresponding La salts in appearance and solubility, only sl. radioactive when freshly made but capable of showing phosphorescence with ZnS when old.

A, argon. One of the inert gases existing in small quantity in the air; colorless, odorless gas; may be condensed to a colorless liquid that boils at -185.7° and solidifies at -189.2° ; two and a half times more sol. than N in water; sp. gr.: gas, 1.782; liquid, 1.402; solid, 1.65; At. No. 18; At. Wt. 39.91; Mol. Wt. probably the same; val. 0; most inert substance known; does not unite with other elements; solid A is white and cryst.; M. P. -189.2° ; B. P. -185.7° ; is said to form a cryst. hydrate with ice water under high pressure; 2 isotopes; critical temp. -122.4° ; critical pressure 47.9 atmospheres.

Argon

A compounds are thus far unknown.

Be, beryllium, less correctly known as *glucinum*. White or steel colored, hard, malleable, hexagonal cryst.; hardness 6 or 7; stable in air at ordinary temp.; only sl. changed by heating except at high temp., when it burns to the oxide; not acted on by cold or hot water; sol. in dil. HCl and KOH + Aq, giving H_2 ; insol. in NH_4OH ; sol. in dil. H_2SO_4 , giving H_2 , and in concd. H_2SO_4 , giving SO_2 ; sol. in hot, concd. HNO_3 ; slowly and superficially oxidized in moist air; sublimes at high temp. in an atmosphere of H_2 ; combines directly with Cl_2 , S, and Br $_2$; combines less actively with I_2 ; alloys easily with certain metals; At. No. 4; At. Wt. 9.02; Mol. Wt. unknown; sp. gr. 1.8; val. 2; M. P. 1350° ; B. P. 1500° ; 1 isotope.

Beryllium

BeBr_2 , beryllium bromide, glucinum bromide. Long, white needles; sol. in water; nearly completely hydrolyzed in water; M. P. 490° .

BeCO_3 , beryllium carbonate, glucinum carbonate. White, sol. compound; loses CO_2 readily, yielding the basic salt, which is white and insol. in water, and reverts to the normal salt when CO_2 is passed into the soln. in which the basic carbonate is suspended.

BeCl_2 , beryllium chloride, glucinum chloride. White, deliquescent, volatile needle cryst.; sweetish taste; hydrolyzes in water; sol. in water; decomp. to BeO and O_2 when heated in air; sol. in alcohol and ether; insol. in acetone and liquid NH_3 ; forms many double salts; cryst. with $4\text{H}_2\text{O}$; M. P. 440° ; B. P. c. 520° ; sp. gr. 1.89.

Be(OH)_2 , beryllium hydroxide, beryllium hydrate, glucinum hydroxide, glucinum hydrate. Voluminous, gelatinous ppt.; readily sol. in acids, alkalies and alkaline carbonate solns. when freshly pptd.; less sol. after standing or being boiled in water; very sl. sol. in water; sol. in H_2SO_4 + Aq and H_2CO_3 + Aq; forms BeO when ignited.

$\text{Be(NO}_3)_2$, beryllium nitrate, glucinum nitrate. Cryst. from a strong HNO_3 soln. as very hygroscopic cryst. $\text{Be(NO}_3)_2 \cdot 3\text{H}_2\text{O}$, which are sol. in water and form a basic salt when heated; M. P. of the hydrated salt is 60° ; sol. in alcohol.

BeO , beryllium oxide, glucinum oxide, beryllia, glucina. Loose, white, voluminous, tasteless, amorph. powder, or hard, hexagonal cryst.; infusible; insol. in water; sol. in acids, but with difficulty after ignition; sol. in fused KOH; sol. in hot, concd. H_2SO_4 ; sol. in hot concd. acids; M. P. 2400° ; sp. gr. 3.02.

BeSO_4 , beryllium sulfate, glucinum sulfate. White salt that cryst. with 1, 2, 4 and 6 molecules of cryst. water; the hydrated sulfate yields the anhydrous salt when heated to 229° , and the oxide at higher temp.; sol. in water, 43 g. of the anhydrous salt in 100 g. of water at 30° , 90 g. at 95° ; sp. gr. of BeSO_4 is 2.44.

BeS , beryllium sulfide, glucinum sulfide. Of doubtful existence; said to be a grayish fused mass; acids evolve H_2S .

NON-METALS AND RARE METALS

Boron

B, boron. A non-metal, somewhat resembling C; occurs in two forms,—amorph. and cryst.; amorph. B is a greenish brown, opaque, tasteless, odorless powder; non-conductor of electricity; very infusible; insol., or possibly very sl. sol. in water; insol. in alcohol, ether and solns. of caustic alkalies; is non-metallic in its reactions; heated in oxygen it burns with a green flame to B_2O_3 ; heated in air it forms B_2O_3 and BN; decomp. H_2O at red heat; decomp. steam to boric acid and H_2 ; oxidized by heating with KNO_3 , K_2CO_3 , KOH, concd. HNO_3 , concd. H_2SO_4 , or aqua regia; amorph. B combines with Br; so-called cryst. B reacts similarly to amorph. B, but the reactions occur only at high temp.; it is oxidized with great difficulty; At. No. 5; At. Wt. 10.82; Mol. Wt. probably the same; val. 3; sp. gr. 2; M. P. 2300° ; B. P. (2550°).

BBr_3 , boron bromide, boron tribromide. Colorless liquid; fumes strongly; reacts with water forming HBr soln. and H_3BO_3 soln.; sol. in alcohol; M. P. -45° ; sp. gr. of liquid 2.6.

$B_2(CO_3)_3$, boron carbonate. Unknown.

BCl_3 , boron chloride, boron trichloride. Colorless liquid; highly refractive; fumes in air; decomp.; heat expands it greatly; distills easily to a colorless vapor of sp. gr. 4.1; decomp. by water to HCl soln. and H_3BO_3 soln.; decomp. by alcohol; M. P. -107° ; B. P. 18° ; sp. gr. 1.4.

$B(OH)_3$, not known as boron hydroxide, but as boric acid; see boric acid under Acids.

$B(NO_3)_3$, boron nitrate. Unknown.

B_2O_3 , boron oxide, boron trioxide, boric anhydride. Very stable, semi-transparent, colorless, brittle, odorless, glass-like solid; volatilizes at high temp.; non-volatile in air; volatilizes in steam or alcohol vapor; non-conductor of electricity; deliq.; sol. in water to form boric acid, the temp. rising during soln.; sol. in $HC_2H_3O_2$, hot, concd. HCl, HNO_3 and H_2SO_4 ; from the last three it separates on cooling or dilution with water; insol. or sl. sol. in alcohol; sol. in HF; fused B_2O_3 dissolves many metallic oxides giving characteristically colored glass-like masses; sp. gr. liquid 1.85.

$B_2(SO_4)_3$, boron sulfate. Unknown.

B_2S_3 , boron sulfide. White, glassy solid, or silky cryst.; sometimes yellow; fusible; decomp. by water violently; strong odor; irritates the eyes; insol. in most solvents; combines with alcohol and ether; may be melted in H_2 ; M. P. 310° ; sp. gr. 1.55.

Bromine

Br, bromine. Dark brownish red, volatile liquid; the only element except Hg which is liquid at ordinary temp.; very similar to Cl but less active; almost black when in considerable bulk; very irritating odor; vaporizes easily at ordinary temp.; vapor is yellowish red, poisonous, and acts violently on the mucous membrane; non-conductor of electricity; sparingly sol. in water, about 3 parts per 100 parts, with production of heat to a reddish or yellowish soln., called "bromine water," which decomp. slowly on standing, more quickly in direct sunlight, with formation of HBr and O_2 ; with water at 0° it forms $Br_2 \cdot 10H_2O$, which is red, cryst., and decomp. at 15° ; more sol. in alcohol than in water; miscible in all proportions with ether, CS_2 and chloroform; sol. in concd. HCl, $HBr + Aq$ and in liquid SO_2 ; more sol. in HCl than in water; sol. in concd. aq. solns. of KBr and of other metallic bromides, frequently with formation of perbromides; aq. solns. of KOH and NaOH are decomp. by Br, with formation of bromide and bromate of the metal; Br combines directly with most of the elements, particularly the metals, often with production of much heat and sometimes light; solidifies at -7.2° to a brownish mass with conchoidal fracture or lead gray cryst. mass with metallic luster; cryst. at 4° with $10H_2O$ as red octahedral cryst. that decomp. at 15° to Br_2 and H_2O ; At. No. 35; At. Wt. 79.916; Mol. Wt. 159.832; sp. gr. of liquid is 3.119, of vapor is 5.5; of solid 3.4; M. P. -7.2° ; B. P. 58.78° ; 2 isotopes.

Bromine bromide is unknown, unless molecular Bromine, Br_2 , might possibly be considered as bromide of bromine.

Bromine carbonate is unknown.

$BrCl$, bromine chloride. Reddish yellow liquid; mobile and very volatile; gives off a deep yellow irritating vapor in which metals burn, forming chlorides and bromides; sol. in water, CS_2 , and ether; decomp. at 10° .

The name *bromine hydroxide* is sometimes incorrectly given to pentahydrated bromine; see under **bromine**.

Bromine nitrate, bromine oxide, bromine sulfate and bromine sulfide are unknown.

Caesium

Cs, caesium. Silver white, soft, ductile metal; oxidizes rapidly in air, with production of heat and light; decomp. water violently at ordinary temp., with ignition of the H_2 evolved; burns with a reddish violet flame; color of metal sometimes yellow due to impurity; probably the most active metal known; most easily fusible of the alkali metals; it has the lowest B. P. and highest sp. gr. of the alkali metals; occasionally ignites spontaneously in moist air; very sol. in liquid NH_3 ; forms an amalgam with Hg; At. No. 55; At. Wt. 132.81; val. 1; sp. gr. 1.90; M. P. 26° ; B. P. 670° ; 1 isotope.

CsBr, caesium bromide, caesium monobromide. Sol. in water; M. P. 636° ; sp. gr. 4.44.

CsBr₃, caesium tribromide. M. P. 180° .

Cs₂CO₃, caesium carbonate. Of doubtful existence; said to be hydrated deliq. cryst. that melt when heated leaving the anhydrous salt; sol. in alcohol.

CsHCO₃, caesium acid carbonate, caesium hydrogen carbonate. Large prisms; sol. in water.

CsCl, caesium chloride. Small white cubes; deliq.; volatile; decomp. when heated in air; easily sol. in alcohol; insol. in acetone; sol. in water, 161 g. in 100 g. of water at 0° , 186 g. at 20° , 270 g. at 100° ; M. P. 646° ; sp. gr. 3.97.

CsOH, caesium hydroxide, caesium hydrate. Grayish white solid; not decomp. by heat; very deliq. in air with production of much heat; the strongest of all bases; sol. in water and alcohol; M. P. 272° ; sp. gr. 3.6.

CsNO₃, caesium nitrate. Small shiny prisms; cooling niter-like taste; sol. in alcohol; sol. in water, 9 g. in 100 g. of water at 0° , 23 g. at 20° , 197 g. at 100° ; M. P. 414° ; sp. gr. 3.7.

Cs₂O, caesium oxide, caesium monoxide. Orange powder or orange red cryst.; absorbs water and CO_2 from the air; decomp. by water and liquid NH_3 ; sp. gr. 4.3.

Cs₂O₂, caesium oxide, caesium dioxide. Said to exist; decomp. by water.

Cs₂O₃, caesium oxide, caesium trioxide. Decomp. by water; M. P. 400° ; sp. gr. 4.2.

Cs₂O₄, caesium oxide, caesium tetroxide. Decomp. by water; M. P. 600° .

Cs₂SO₄, caesium sulfate. Hard, short prisms; insol. in alcohol; sol. in water, 167 g. in 100 g. of water at 0° , 178 g. at 20° , 220 g. at 100° ; M. P. 1010° ; sp. gr. 4.2.

CsHSO₄, caesium acid sulfate, caesium hydrogen sulfate. Prisms.

Cs₂S, caesium sulfide, caesium monosulfide. Deliq.; very sol. in water; cryst. with $4H_2O$.

Cs₂S₂, caesium sulfide, caesium disulfide. Sol. in water; M. P. 400° .

Cs₂S₃, caesium sulfide, caesium trisulfide. Sol. in water; M. P. 217° .

Cs₂S₄, caesium sulfide, caesium tetrasulfide. Sol. in water; insol. in abs. alcohol; M. P. 160° .

Cs₂S₅, caesium sulfide, caesium pentasulfide. Sol. in alcohol; M. P. 210° ; sp. gr. 2.8.

Cs₂S₆, caesium sulfide, caesium hexasulfide. M. P. 186° .

Carbon

C, carbon. Three allotropic forms are known,—diamond, graphite and amorph. carbon; all forms are insol. in all solvents; At. No. 6; At. Wt. 12.000; Mol. Wt. probably the same; unchanged by acids; has not been melted or vaporized; val. 4, occasionally 2; sp. gr. varies with the allotropic form; B. P. 4200° ; 1 isotope.

Diamond. Colorless, transparent, very refractive and dispersive, cryst. solid; or regular octahedra and derived forms; colored yellow, brown, blue, or black by impurities; hardest known substance, 10 on Mohs' scale of hardness; rather brittle; poor conductor of heat and electricity; sp. gr. 3.51; burned completely to CO_2 when heated strongly in O_2 ; sol. in molten iron at 1160° ; not acted on by $KClO_3$ and fuming HNO_3 .

Graphite, black lead, kish, mineral carbon, plumbago. Occurs both cryst. and amorph.; hexagonal, rhombic cryst. or iron gray, metal-like, lustrous, smutty, hard, opaque solid; fair conductor of heat and electricity; burns in O_2 to CO_2 at a high temp., but more slowly than diamond; leaves a black streak on paper; sp. gr. 2.255; is changed by $KClO_3$ and fuming HNO_3 to graphitic acid; M. P. 3500° .

Amorphous carbon. Hard coal, anthracite; soft coal, bituminous; coke, gas-retort carbon, retort graphite, metallic carbon, retort carbon, gas carbon; lamp-black, charcoal, fitt-char, soot, gas black, cork black, Germantown black, ivory black, bone charcoal, bone black, animal charcoal, carbon black, smoke black, vegetable black, thermatomic carbon. The form and color varies with the

Carbon
Cont.

variety; generally amorph. C is a dense black, lusterless solid or powder; acted on slowly or not at all by reagents; electric conductivity varies; charcoal absorbs large volumes of gases; amorph. C is sol. in KClO_3 and fuming HNO_3 ; insol. in molten Fe at 1160° , but becomes sol. therein by heating to 1400° ; sp. gr. c. 1.8. Many forms of amorph. C are impure.

C_2Br_4 , carbon bromide, carbon dibromide. White cryst.; decomp. by hot Zn or Cu or their oxides, giving metallic bromides and C or CO_2 ; M. P. 53° .

CBr_4 , carbon bromide, carbon tetrabromide. Hard prisms; insol. in alcohol and ether; easily sol. in CS_2 ; decomp. at 200° .

CBr_4 , carbon bromide, carbon tetrabromide. White shiny scales; ethereal odor; insol. in water; very sol. in alcohol and ether; partially decomp. at 200° ; M. P. 91° ; B. P. 189° ; sp. gr. 3.4.

Carbon carbonate is unknown.

CCl_4 , carbon chloride, carbon dichloride. Colorless liquid; ethereal odor; B. P. 122° ; sp. gr. 1.6.

CCl_4 , carbon chloride, carbon trichloride. Hard, transparent prisms; insol. in water; sol. in alcohol and ether; M. P. 187° ; B. P. the same; sp. gr. 2.

CCl_4 , carbon chloride, carbon tetrachloride, benzoinform. Colorless liquid; ethereal odor, resembling chloroform; not flammable; very sl. sol. in water, 1 g. in 100 g. of water at 0° , 0.08 g. at 20° ; unchanged by $\text{KOH} + \text{Aq}$; solidifies as cryst. at -24° ; good solvent for fats; B. P. 77° ; sp. gr. 1.6.

Carbon hydrazide is of doubtful existence.

Carbon nitrate is unknown.

CO, carbon oxide, carbon monoxide, "carbonic oxide"; more correctly but less frequently, carbonous oxide, formic anhydride. Colorless, tasteless gas; poisonous when inhaled; sl. odor; non-supporter of combustion; burns in air with blue flame to CO_2 ; may be liquefied at low temp. and great pressure to a colorless liquid that boils at -190° and solidifies at -199° ; partly decomp. at c. 1300° to C and CO_2 ; sp. gr. 0.97; sl. sol. in water; reacts with moist KOH or NaOH to form an alkali formate, M_2CO_2 ; absorbed by $\text{BaO}_2\text{H}_2 + \text{Aq}$ or $\text{CaO}_2\text{H}_2 + \text{Aq}$, more rapidly by ether and alcohol; sol. in HCN ; large amounts of CO are absorbed by solns. of cuprous chloride in HCl , NH_4OH or NH_4 salt solns.; decomp. to C and alkali carbonate when heated to redness with Na or K; M. P. -207° .

CO_2 , carbon oxide, carbon dioxide, carbonic anhydride, carbonic acid gas, carbonic acid anhydride; incorrectly sometimes simply carbonic acid. Heavy, colorless, incombustible gas; non-supporter of combustion; reduced to C when heated with K, Na, Mg or Al; reduced to CO by Zn or C; sol. in water to form carbonic acid; the soln. is unstable and decomp. on standing or on heating to CO_2 and H_2O ; absorbed by moist alkalies and alkaline-earths, forming carbonates; sp. gr. 1.53; partly decomp. to CO and O_2 at c. 1300° ; may be condensed by low temp. and great pressure to a colorless, mobile, refractive liquid, that is a non-conductor of electricity, mixes with alcohol, ether and CS_2 , does not mix with water, but stays on its surface, and has a sp. gr. of 1.01; solid CO_2 is a white, loose, snow-like solid or powder, poor conductor of heat, evaporates slowly, may be compressed to a white solid, melts at c. -70° or -56° under 5 atmospheres; volatilizes rapidly and then dissolves when immersed in water, forms a semi-fluid paste with alcohol or ether, and burns the skin when pressed against it; critical temp. is 30.9° ; critical pressure is 77 atmospheres; B. P. liquid CO_2 is -78.2° .

C_3O_2 , carbon oxide, carbon suboxide. Said to exist as a colorless liquid with disagreeable odor; B. P. 7° .

Carbon sulfate is unknown.

CS, carbon sulfide, carbon monosulfide. Red powder; insol. in water and alcohol; sl. sol. in CS_2 and ether; sol. in dil. HNO_3 , but not in dil. HCl or H_2SO_4 ; decomp. at 200° to C and S; sp. gr. 1.6.

CS_2 , carbon sulfide, carbon disulfide, carbon bisulfide, thiocarbonic anhydride, sulfoarbonic acid. Colorless liquid; very mobile and highly refractive; ethereal odor when pure; usually has a very offensive odor; poisonous when inhaled; vapor is extremely and explosively flammable, with a blue flame, forming CO_2 and SO_2 ; very sl. sol. in water; vapor of CS_2 is easily sol. in an alcoholic soln. of KOH , but only sl. sol. in $\text{KOH} + \text{Aq}$; miscible with ether, abs. alcohol, and liquid CO_2 ; good solvent for fats, resins, rubber, I, P, and S; retards the putrefaction of meat; decomp. by heat to C and S; B. P. 46° ; sp. gr. 1.26.

CS_2 , carbon sulfide, tricarbon disulfide. Deep red liquid; insol. in water; sol. in CS_2 , ether, and alcohol, sometimes with decomp. in the last named; violent lachrymatory.

Cp, cassiopeium. Another name for lutecium. See **Lu**.

**Cassio-
peium**

Ct, celtium. Another name for hafnium. See **hafnium**.

Celtium

Ce, cerium. Steel-gray, very lustrous, malleable, very ductile metal, soft enough to cut with a knife; resembles steel in appearance; conducts electricity poorly and heat fairly well; dissolves Al_2O_3 ; reduces CO and CO_2 ; good reducing agent; emits sparks when scraped with a file; stable in dry air, but is superficially oxidized in moist air; burns when heated in air, more easily than does Mg , forming oxide and producing heat and much light; ignites spontaneously when finely divided; burns in N_2 , H_2 , Cl_2 , Br_2 , I_2 vapors, S vapor and P vapor, forming compounds with these elements; decomp. cold water slowly, hot water quickly, evolving H_2 slowly; not attacked by cold, concd. H_2SO_4 or red, fuming HNO_3 ; sol. in dil. H_2SO_4 , HNO_3 and dil. or concd. HCl ; insol. in NaOH ; sol. in $\text{KCl} + \text{Aq}$ and $\text{NH}_4\text{Cl} + \text{Aq}$; forms many alloys with metals; forms two series of compounds, cerous and ceric; At. No. 58; At. Wt. 140.25; Mol. Wt. unknown; val. 3 and 4; sp. gr. 6.90; M. P. 640° ; B. P. 1400° ; 2 isotopes.

Cerium

CeBr_3 , cerium bromide, cerous bromide. White deliq. needles; decomp. when heated in air; sol. in water and acetone.

$\text{Ce}_2(\text{CO}_3)_3$, cerium carbonate, cerous carbonate. Probably unknown; an alkaline carbonate ppts. from a ceric soln. a yellow, gelatinous basic ceric carbonate of varying compn.

$\text{Ce}(\text{CO}_3)_2$, cerium carbonate, ceric carbonate. Ppt.; insol. in water.

CeCl_3 , cerium chloride, cerous chloride. White, deliq. solid; easily sol. in water with hissing and production of heat; sol. in alcohol and acetone; M. P. 848° ; sp. gr. 3.9.

CeCl_4 , cerium chloride, ceric chloride. Known only in soln.; decomp. when heated.

$\text{Ce}(\text{OH})_3$, cerium hydroxide, cerium hydrate, cerous hydroxide, cerous hydrate. White, gelatinous ppt.; darkens on exposure to air; easily sol. in acids; sol. in excess of alkaline hydroxide solns.

$\text{Ce}(\text{OH})_4$, cerium hydroxide, cerium hydrate, ceric hydroxide, ceric hydrate. Not known pure; an alkaline hydroxide soln. ppts. a yellow gelatinous hydrated oxide; sol. in HNO_3 and H_2SO_4 to a red soln.; sol. in HCl to a cerous salt; insol. in $\text{HC}_2\text{H}_3\text{O}_2$.

$\text{Ce}(\text{NO}_3)_3 \cdot 6\text{H}_2\text{O}$, cerium nitrate, cerous nitrate. Cryst. masses; decomp. at 200° ; easily sol. in water and alcohol; forms double nitrates.

$\text{Ce}(\text{NO}_3)_4$, cerium nitrate, ceric nitrate. Known only in an orange colored soln. which ppts. a basic salt when soln. is heated; forms double nitrates.

Ce_2O_3 , cerium oxide, cerous oxide. Gray solid or powder; sol. in many acids, forming cerous salts; insol. in HCl after ignition.

CeO_2 , cerium oxide, ceric oxide, cerium dioxide. Very pale yellow solid; white when cold, yellow when hot; sol. in concd. H_2SO_4 ; sol. in HNO_3 ; less sol. in HCl ; insol. or sparingly sol. in acids after ignition; volatilizes at c. 1900° without decomp. or melting; M. P. 1950° ; sp. gr. 7.3.

Other oxides are said to exist.

$\text{Ce}_2(\text{SO}_4)_3$, cerium sulfate, cerous sulfate. The anhydrous salt is easily sol. in water at 0° ; the numerous hydrated sulfates become anhydrous at 400° ; hardens when treated with a small amount of water; forms double sulfates; sp. gr. 3.9.

$\text{Ce}(\text{SO}_4)_2$, cerium sulfate, ceric sulfate. Deep yellow, cryst. powder; sol. in water, the aq. soln. hydrolyzing and pptg. basic sulfates; decomp. by heat at 300° to CeO_2 ; insol. in concd. H_2SO_4 ; forms double sulfates.

$\text{Ce}_2(\text{SO}_4)_3 \cdot 2\text{Ce}(\text{SO}_4)_2 \cdot 24\text{H}_2\text{O}$, cerous ceric sulfate, cero-ceric sulfate. Decomp. by water; sol. in dil. HCl with decomp.

Ce_2S_3 , cerium sulfide, cerous sulfide, cerium trisulfide. Red, translucent cryst., or bright red to black, amorph. solid according to the temp. used in the preparation; burns to CeO_2 and SO_2 ; sl. decomp. by warm water; easily sol. in dil. acids; sp. gr. 5.02.

Ce_2S_4 said to exist.

Cl , chlorine, dephlogisticated muriatic acid gas. Greenish yellow gas, becoming darker in color when heated, but losing its color slowly on standing; very irritating odor; poisonous; attacks mucous membrane vigorously; absorbed by charcoal; not combustible in O_2 ; burns in H_2 , forming HCl ; sol. in water with production of heat, forming "chlorine water," a greenish yellow liquid, with properties of gaseous Cl_2 ; $\text{Cl}_2 + \text{Aq}$ freezes at 0° , giving $\text{Cl}_2\text{SH}_2\text{O}$, chlorine

Chlorine

Chlorine
Cont.

hydroxide or *chlorine hydrate*, white, octahedral cryst.; $\text{Cl}_2 + \text{Aq}$ decomp. quickly in sunlight to HCl and O_2 ; gaseous Cl_2 may be condensed at 15° and 5.7 atmospheres or at -40° and 1 atmosphere to a dark yellow liquid of sp. gr. 1.557; B. P. -34.6° and insol. in water; Cl_2 unites directly with all elements except O, N, C and F, but indirectly with O, N and C; At. No. 17; At. Wt. 35.458; Mol. Wt. 70.916; sp. gr. of gas, 2.5; val. 1; M. P. -101.6° .

ClBr , *chlorine bromide*. More correctly called *bromine chloride*. See *bromine chloride* under *Bromine*.

Chlorine carbonate is unknown.

Chlorine chloride is unknown, unless molecular chlorine, Cl_2 , might possibly be considered as chloride of chlorine.

The name *chlorine hydroxide* is sometimes incorrectly given to the pentahydrated chlorine; see under *Chlorine*.

Chlorine nitrate is unknown.

Cl_2O , *chlorine oxide*, *chlorine monoxide*, *hypochlorous acid anhydride*, *hypochlorous anhydride*. Reddish yellow gas, with very irritating odor; unstable; condenses at c. -20° to a blood red liquid that boils at c. -17° ; both gas and liquid are very easily decomp., often with explosive violence; sol. in water, forming hypochlorous acid; reacts with powdered metals and metallic oxides to form chlorides and oxides or oxychlorides, often explosively; decomp. by H_2 in sunlight explosively, forming HCl and H_2O ; strong oxidizer and bleacher; one volume of water absorbs 200 volumes of Cl_2 at 0° ; M. P. -20° .

ClO_2 , *chlorine oxide*, *chlorine dioxide*, *chlorine tetroxide*, *chlorine peroxide*, formerly called *hypochloric acid*. Yellowish green gas; strong odor; condenses a little below 0° to a red-brown liquid, and solidifies at c. -59° to hard, brittle, red cryst.; both gas and liquid are frightfully explosive; sol. in water; S and P burn in ClO_2 explosively; H_2 decomp. it explosively, forming HCl and H_2O ; at 4° one volume of water absorbs 20 volumes of ClO_2 , forming HClO_2 and HClO_3 ; M. P. -76° ; B. P. 10° .

Cl_2O_3 , Cl_2O_6 , and Cl_2O_7 are said to exist; the last named is probably a colorless, volatile, explosive liquid.

Chlorine sulfate is unknown.

Chlorine sulfide is better known as *sulfur chloride*; there are three known; see *sulfur chlorides* under *Sulfur*.

Columbium

Cb, *columbium*, formerly called *niobium* (Nb). Steel-gray, lustrous metal; insol. in HCl , HNO_3 or aqua regia; sol. in concd. H_2SO_4 , easily on warming; burns to Cb_2O_5 when heated in air; At. No. 41; At. Wt. 93.1; Mol. Wt. unknown; sp. gr. 8.4; val. 3 and 5; malleable and ductile; oxidizes rapidly in air when powdered; combines directly with H_2 ; combines with N_2 and Cl_2 at high temp.; sl. sol. in HF , in HF and H_2SO_4 , and in HF and HNO_3 ; reacts easily with fused alkalis and fused oxidizing agents, forming *columbates*; M. P. 1950° ; B. P. 3300° .

CbBr_5 , *columbium bromide*, *columbium pentabromide*. Purple red solid; turns yellow and volatilizes when heated.

Columbium carbonate is unknown.

CbCl_3 , *columbium chloride*, *columbium trichloride*. Dark gray, metallic, cryst. solid; non-volatile; non-deliq.; gives off white fumes when heated in air; not decomp. by water or NH_4OH ; reduces CO_2 when heated therein; oxidized by HNO_3 .

CbCl_5 , *columbium chloride*, *columbium pentachloride*. Yellow needles; vapor is yellow; nearly white when pure; sublimates at 125° ; fumes in air, evolving HCl ; decomp. by water, giving HCl and hydrated Cb_2O_5 ; sol. in alcohol, CCl_4 , S_2Cl_2 and chloroform; sol. in cold concd. HCl and concd. H_2SO_4 , but solns. often become gelatinous; sol. in $\text{KOH} + \text{Aq}$; M. P. 194° ; B. P. 240° ; sp. gr. 2.85.

$\text{Cb}(\text{OH})_3$, *columbium hydroxide*, *columbium hydrate*, *columbium trihydroxide*. Of doubtful existence; said to be a brownish ppt.; see *hydrated columbium oxide* under *columbium oxide*.

$\text{Cb}(\text{NO}_3)_3$, *columbium nitrate*. Of doubtful existence.

CbO , *columbium oxide*, *columbium monoxide*; sometimes written Cb_2O_2 , *columbium dioxide*. Black, lustrous, regular cryst.; insol. in water; sol. in concd. H_2SO_4 after long heating; sol. when moist in hot, dil. HCl ; insol. in hot HNO_3 ; less sol. in aqua regia than in HCl .

CbO_2 , *columbium oxide*, *columbium dioxide*; sometimes written Cb_2O_4 , *columbium tetroxide*. Black powder with blue reflection; insol. in water and acids; burns to Cb_2O_5 when heated.

Cb_2O_6 , *columbium oxide*, *columbium pentoxide*, *columbic anhydride*. White, amorph. powder; or tabular cryst.; turns yellow when heated, but turns back

to white on cooling; insol. in water; sl. sol. in hot HCl; sol. in hot concd. H_2SO_4 ; the soln. may be diluted without pptn., but on heating all the Cb_2O_3 is reprecipitated; non-volatile; sol. in fused KHSO_4 ; sol. in HF; sol. in $\text{KOH} + \text{Aq}$; the hydrated oxide is called *columbic acid* (formerly called *niobic acid*) and forms salts called *columbates* (formerly called *niobates*); M. P. 1520° ; sp. gr. 4.6.

Another oxide is said to exist.

Columbium sulfate is said to exist; sol. in water.

Columbium sulfide is unknown, but Cb_2OS_3 , *columbium oxysulfide*, is known as a black powder, insol. in water and acids.

Colum-
bium
Cont.

Di, *didymium*. Said to be a mixture of the two elements, neodymium and praseodymium; see **Neodymium** and **Praseodymium**.

Didymium

Dy (Ds), *dysprosium*. A metal of the rare earth group; prevailing color of salt solns. is green; At. No. 66; At. Wt. 162.52; val. 3.

DyBr_3 , *dysprosium bromide*. Anhydrous powder.

$\text{Dy}_2(\text{CO}_3)_3 \cdot 4\text{H}_2\text{O}$, *dysprosium carbonate*. Powder; insol. in water; loses $3\text{H}_2\text{O}$ at 15° .

DyCl_3 , *dysprosium chloride*. Shiny, yellow cryst.; cryst. with $6\text{H}_2\text{O}$; deliq.; sol. in water to a green soln.; M. P. 680° ; sp. gr. 3.7.

$\text{Dy}(\text{OH})_3$, *dysprosium hydroxide*. Amorph. ppt.; insol. in water.

$\text{Dy}(\text{NO}_3)_3$, *dysprosium nitrate*. Cryst. with $5\text{H}_2\text{O}$ as yellow cryst.; loses its cryst. water in dry air; sol. in water; M. P. 88.6° .

Dy_2O_3 , *dysprosium oxide, dysprosia*. White powder; sol. in acids; sp. gr. 7.8. $\text{Dy}_2(\text{SO}_4)_3$, *dysprosium sulfate*. Cryst. with $8\text{H}_2\text{O}$ as yellow cryst.; stable in air at 110° ; loses its cryst. water at 360° ; decomp. to Dy_2O_3 at white heat; forms double sulfates.

Dysprosium sulfide is unknown.

Dyspro-
sium

Er, *erbium*. This name was given to what was at first supposed to be an element but which was later discovered to be a mixture of several metals of the rare earth group; it was later obtained in pure state; dark gray metallic powder; decomp. water; its salts give rose-colored solns.; At. No. 68; At. Wt. 167.7; Mol. Wt. unknown; val. 3.

ErBr_3 , *erbium bromide*. Very deliq. and rose colored; sol. in water.

$\text{Er}_2(\text{CO}_3)_3$, *erbium carbonate*. Said to exist.

ErCl_3 , *erbium chloride*. Deliq.; rose colored; sol. in water; forms a cryst. oxychloride, ErOCl .

$\text{Er}(\text{OH})_3$, *erbium hydroxide, erbium hydrate*. Of doubtful compn.; insol. in $\text{KOH} + \text{Aq}$ and $\text{NaOH} + \text{Aq}$; easily sol. in acids.

$\text{Er}(\text{NO}_3)_3$, *erbium nitrate*. Cryst. with $5\text{H}_2\text{O}$ as red crystals; stable in air; sol. in water.

Er_2O_3 , *erbium oxide, erbia*. Pale rose-colored powder; infusible; sol. difficultly but completely in warm HNO_3 , H_2SO_4 , or HCl ; sp. gr. 8.6.

Er_2O_3 said to exist.

$\text{Er}_2(\text{SO}_4)_3$, *erbium sulfate*. Rose colored monoclinic cryst.; cryst. with $8\text{H}_2\text{O}$; sol. in water, 43 g. in 100 g. of water at 0° ; forms double sulfates; sp. gr. 3.7.

Er_2S_3 , *erbium sulfide*. Decomp. in moist air; decomp. by acids.

Erbium

Eu, *europium*. One of the rarest of the metals of the rare earth group; its salts form pink colored solns.; At. No. 63; At. Wt. 152.6; val. 3.

EuBr_3 , *europium bromide*. Said to exist.

$\text{Eu}_2(\text{CO}_3)_3$, *europium carbonate*. Known.

EuCl_3 , *europium chloride, europium dichloride, europous chloride*. Colorless and amorph.; sol. in water.

EuCl_3 , *europium chloride*. Yellow needle cryst.; sol. in water.

$\text{Eu}(\text{OH})_3$, *europium hydroxide, europium hydrate*. Ppt.; insol. in water; absorbs CO_2 from the air.

$\text{Eu}(\text{NO}_3)_3$, *europium nitrate*. Forms double nitrates.

Eu_2O_3 , *europium oxide, europium sesquioxide, europia*. White with pink tinge; sp. gr. 7.4.

$\text{Eu}_2(\text{SO}_4)_3$, *europium sulfate*. Cryst. with $5\text{H}_2\text{O}$ as pale pink cryst.; sol. in water; decomp. at high temp.

Eu_2S_3 , *europium sulfide*. Of doubtful existence.

Europium

F, *fluorine*. Pale, yellowish green gas; unpleasant odor; decomp. water, forming ozone and HF; decomp. all organic solvents with great violence; most active of the elements; unites directly with H_2 in the dark; replaces Cl in KCl; unites

Fluorine

NON-METALS AND RARE METALS

Fluorine *Cont.*

directly with many non-metallic elements, and with all metals except Au and Pt; has been liquefied at -187° to a yellow liquid that does not possess the activity of gaseous fluorine; liquid F has a sp. gr. of 1.11 and boils at -187° ; solidifies at -252° to a yellow, then white, mass which explodes on contact with H_2 ; M. P. -223° ; At. No. 9; At. Wt. 19.00; Mol. Wt. 38; val. 1, and possibly 2; 1 isotope.

No oxide and no hydroxide of F are known; no salts of F are known except possibly the sulfide.

Gadolinium

Gd, *gadolinium*. One of the metals of the rare earth group; salts form colorless solns.; At. No. 64; At. Wt. 157.26; val. 3.

GdBr₃, *gadolinium bromide*. Sol. in water and HBr; cryst. with $6H_2O$; sp. gr. of the hydrated salt 2.8.

Gd₂(CO₃)₃, *gadolinium carbonate*. Cryst. with $13H_2O$; a hydroxycarbonate is also known.

GdCl₃, *gadolinium chloride*. White monoclinic prisms; deliq.; cryst. with $6H_2O$ as prismatic cryst.; sp. gr. of hydrated salt 2.4; decomp. by heat.

Gd(OH)₃, *gadolinium hydroxide, gadolinium hydrate*. Insol. in water.

Gd(NO₃)₃, *gadolinium nitrate*. Cryst. with 5 and 6 H_2O ; forms double nitrates; M. P. 92° ; sp. gr. 2.4.

Gd₂O₃, *gadolinium oxide* (?), *gadolinia*. White solid; sp. gr. 7.4; sol. in acids; hygroscopic.

Gd₂(SO₄)₃, *gadolinium sulfate*. Sl. sol. in water; cryst. with $8H_2O$; sp. gr. of hydrated salt 3.0, of the anhydrous salt 4.1.

Gd₂S₃, *gadolinium sulfide*. Yellow solid; hygroscopic; sp. gr. 3.8; decomp. by water and acids.

Gallium

Ga, *gallium*. Gray, lustrous, fairly hard metal, with greenish blue reflection; quadratic octahedra or broad tablets; brittle, but may be hammered into thin plates, which can be bent without breaking; melts at 30° to a silver-white liquid, with faint, reddish reflection; remains in molten state below the melting point; color is bluish gray on a bright surface; soft enough to cut with a knife; liquid Ga has almost as high a surface tension as Hg; expands on solidifying; sol. in NaOH+Aq, evolving H_2 ; sp. gr. of solid Ga is 5.904, of liquid 6.095; easily sol. in aqua regia; slowly sol. in NH_4OH ; combines rapidly with Cl_2 , slowly with Br_2 , and with I_2 only when heated; amalgamates with Hg; alloys with many metals; its alloy with Al decomp. water; may be kept below its M. P. for weeks; unchanged in air at ordinary temp.; at higher temp. it is non-volatile, but is superficially oxidized; does not decomp. water at 100° ; easily sol. in cold HCl; sol. in aqua regia; slowly sol. in warm dil. HNO_3 ; sol. in KOH+Aq; At. No. 31; At. Wt. 69.72; Mol. Wt. unknown; M. P. 29.75° ; B. P. $>1600^{\circ}$; val. 3; 1 isotope, possibly 2.

GaBr₃, *gallium bromide, gallous bromide, gallium dibromide*. White; volatile; deliq.; decomp. by water.

GaBr₃, *gallium bromide, gallic bromide, gallium tribromide*. Colorless, cryst. masses; less volatile than $GaCl_3$; deliq.; sol. in water.

Ga₂(CO₃)₃, *gallium carbonate*. Said to exist.

GaCl₃, *gallium chloride, gallous chloride, gallium dichloride*. White, transparent cryst.; M. P. 175° ; B. P. 535° ; deliq. in moist air; water ppts. a basic chloride.

GaCl₃, *gallium chloride, gallic chloride, gallium trichloride*. Long, white needles; M. P. 75° ; B. P. 215° ; deliq.; sol. in a little water to a clear soln., but ppts. a basic chloride with much water; sp. gr. 2.3.

Ga(OH)₃, *gallium hydroxide, gallic hydroxide, gallium hydrate*. White, gelatinous masses; insol. in water; sol. in NaOH+Aq and KOH+Aq; less sol. in NH_4OH .

Ga(NO₃)₃, *gallium nitrate, gallic nitrate*. White masses; deliq.; sol. in water; decomp. partially at 110° and completely at 200° , leaving Ga_2O_3 .

Ga₂O₃, *gallium oxide, gallium monoxide, gallous oxide*. Grayish blue mass; sol. in HNO_3 , H_2SO_4 and HCl.

Ga₂O₃, *gallium oxide, gallium sesquioxide, gallic oxide*. White solid; sol. in acids; less sol. in acids after ignition; infusible at red heat.

GaSO₄, *gallium sulfate, gallous sulfate*. Said to exist.

Ga₂(SO₄)₃, *gallium sulfate*. Sol. in water, but ppts. a basic salt when boiled; not deliq.; cryst. with alkali sulfates and $24H_2O$ to form alums.

Ga₂S₃, *gallium sulfide, gallic sulfide*. Of doubtful existence.

Germanium

Ge, *germanium*. Grayish white, lustrous, very brittle metal; brilliant metallic luster; melts at c. 900° and cryst. in regular octahedra on cooling; stable in air at ordinary temp.; oxidized to GeO_2 when heated in powder form; insol. in HCl ; easily sol. in aqua regia; decomp. by HNO_3 to the oxide; sol. in concd. H_2SO_4 to the sulfate, evolving SO_2 ; insol. in boiling $\text{KOH} + \text{Aq}$; combines directly with the halogens; At. No. 32; At. Wt. 72.38; Mol. Wt. unknown; sp. gr. 5.36; M. P. 598° ; B. P. (2700°); val. 2 and 4; 1 isotope.

GeBr_4 , *germanium bromide, germanium tetrabromide, germanic bromide*. Colorless liquid; fumes strongly; solidifies below 0° to a white cryst.; decomp. by water, pptg. GeO_2 and evolving much heat; similar to GeCl_4 ; M. P. 26° ; sp. gr. 3.1.

$\text{Ge}(\text{CO}_3)_2$, *germanium carbonate*. Said to exist.

GeCl_3 , *germanium chloride, germanium dichloride, germanous chloride, germanious chloride*. Colorless liquid; fumes in moist air; completely hydrolyzed by water; sol. in concd. HCl .

GeCl_4 , *germanium chloride, germanium tetrachloride, germanic chloride*. Thin, colorless liquid; fumes in air, strongly in moist air; decomp. by water to GeO_2 ; crackles when mixed with water; not attacked by concd. H_2SO_4 ; sl. decomp. by HNO_3 ; M. P. -49° ; sp. gr. 1.87.

$\text{Ge}(\text{OH})_2$, *germanium hydroxide, germanium dihydroxide, germanous hydroxide, germanious hydroxide, germanium hydrate*. Amorph. ppt.; yellow at first, but turns red when heated; insol. in water; sol. in alkaline hydroxide solns.

$\text{Ge}(\text{NO}_3)_4$, *germanium nitrate, germanium tetranitrate, germanic nitrate*. Said to exist.

GeO , *germanium oxide, germanium monoxide, germanous oxide, germanious oxide*. Grayish black solid; sl. sol. in water; insol. in H_2SO_4 ; easily sol. in HCl ; volatile; sol. in alkalis.

GeO_2 , *germanium oxide, germanium dioxide, germanic oxide*. White, gritty solid, or microscopic, rhombic cryst.; somewhat sol. in water to a sour liquid; sol. with difficulty in acids; sol. in solns. of alkalis forming *germanates*; sp. gr. 4.7.

$\text{Ge}(\text{SO}_4)_2$, *germanium sulfate, germanic sulfate*. Said to exist.

GeS , *germanium sulfide, germanium monosulfide, germanous sulfide, germanious sulfide*. Gray black plates; high luster; red by transmitted light; dark red amorph. powder when pptd.; oxidizes to GeO_2 when heated in air; easily sol. in $\text{KOH} + \text{Aq}$; melts and vaporizes without decomp.; sl. sol. in water; sol. in acids; sol. in yellow $(\text{NH}_4)_2\text{S} + \text{Aq}$.

GeS_2 , *germanium sulfide, germanium disulfide, germanic sulfide*. White, amorph. powder; sl. sol. in water, but soln. hydrolyzes; sol. in yellow $(\text{NH}_4)_2\text{S} + \text{Aq}$; sol. in $\text{KOH} + \text{Aq}$ and NH_4OH ; insol. in acids.

Gl, *glucinum*. See **Beryllium**.

Glucinum

Au, *gold (aurum), Cassius purple, purple of Cassius, gold-tin precipitate, gold-tin purple*. The only yellow metal; good luster; stable in air; very soft; pure Au is much softer than the gold alloy used in coins and jewelry under the name "gold"; better conductor of electricity and heat than all metals except Cu and Ag; colloidal Au is scarlet or ruby colored; stable and untarnished in air; sol. in $\text{KCN} + \text{Aq}$ if O_2 is present; melted Au is green; amalgamates with, or dissolves in, Hg; forms alloys with several metals; forms two series of compounds, *aurous* and *auric*; the latter are more stable, but even they are decomp. when heated; sol. in solns. of ferric and cupric salts; sol. in hot concd. H_2SO_4 in the presence of metallic peroxides; most malleable and ductile metal; gold leaf is green by transmitted light, but changes to ruby red when heated to 316° ; pptd. Au is lusterless, brownish yellow, or reddish powder; cryst. Au is almost octahedral; not acted on by water; insol. in HNO_3 , concd. HCl or H_2SO_4 ; easily sol. in aqua regia, or any mixture evolving Cl or Br; At. No. 79; At. Wt. 197.2; Mol. Wt. unknown; sp. gr. 19.3; val. 1 and 3; M. P. 1063° ; B. P. 2600° .

AuBr , *gold bromide, gold monobromide, aurous bromide*. Grayish yellow; resembles talc; stable in air; insol. in water, HNO_3 , and H_2SO_4 ; decomp. by heat at 115° ; sol. in NH_4OH with decomp.; slowly decomp. by alcohol, ether and acetone.

AuBr_3 , *gold bromide, gold tribromide, auric bromide*. Dark brown powder; non-deliq.; sl. sol. in water and more in ether; melts at 160° with decomp.

AuBr_2 or **Au_2Br_3** , or **$\text{AuBr} \cdot \text{AuBr}_3$** , *gold bromide, auro-auric bromide*. Black masses; non-deliq.; decomp. by heat at 115° ; slowly sol. in water.

Gold carbonate is of doubtful existence.

Gold

NON-METALS AND RARE METALS

Gold
Cont.

AuCl, *gold chloride, gold monochloride, aurous chloride*. Yellow or yellowish white powder; insol. in water, but decomp. thereby when heated; sol. in KBr + Aq and in NH_4OH ; insol. in dil. HNO_3 ; decomp. by concd. HNO_3 , alcohol, ether and acetone; decomp. at 289° ; sp. gr. 7.4.

AuCl₃, *gold chloride, gold trichloride, auric chloride*. Large, red brown, or orange red, cryst. leaflets; very deliq.; sol. in water to a yellow soln., 68 g. in 100 g. of water; the aq. soln. is easily reducible; decomp. at 185° to Cl and AuCl, at higher temp. to metallic gold; sol. in concd. HCl and dil. HNO_3 ; melts at 254° with decomp.; sp. gr. 3.9.

AuCl₃ or **Au₂Cl₆** or **AuCl.AuCl₃**, *gold chloride, auro-auric chloride*. Hard, dark red, very hygroscopic solid; decomp. by water; decomp. when heated to 250° ; sp. gr. 5.1.

AuOH, *gold hydroxide, aurous hydroxide, gold hydrate*. Decomp. by heat.

Au(OH)₃, *gold hydroxide, gold trihydroxide, auric hydroxide, gold hydrate, auric acid*. Behaves more like an acid than a base and forms salts called *aurates*; almost insol. in most acids; easily sol. in concd. HNO_3 ; sl. sol. in concd. H_2SO_4 ; insol. in cold, but sol. in boiling, $\text{KOH} + \text{Aq}$.

Auro-auric hydroxide is said to exist.

AuNO₃, *gold nitrate, aurous nitrate*. Said to exist.

Au(NO₃)₃, *gold nitrate, auric nitrate*. Of doubtful existence;

Au(NO₃)₃.HNO₃.3H₂O, *auri-nitric acid*, is better known; decomp. by water.

Au₂O₃, *gold oxide, gold monoxide, aurous oxide*. Grayish violet solid; decomp. at c. 250° to Au and O₂; insol. in water or alcohol; decomp. by hot HCl to Au and AuCl₃; sol. in cold aqua regia; insol. in HNO_3 , H_2SO_4 and $\text{HC}_2\text{H}_3\text{O}_2$.

Au₂O₃, *gold oxide, auric oxide*. Dark brown powder; gives off O₂ at c. 110° ; at 160° AuO remains, and at 250° Au remains; insol. in water and acids; sol. in $\text{NaOH} + \text{Aq}$.

AuO or **Au₂O.Au₂O₃**, *gold oxide, auro-auric oxide*. Dark olive-brown powder; very hygroscopic; sol. in cold HCl.

Aurous sulfate and *auric sulfate* are of doubtful or complex compn.

Au₂(SO₄)₃, *gold sulfate, auro-auric sulfate*. Scarlet prisms; lustrous; rapidly deliq. with decomp.; decomp. by water, dil. HNO_3 and glacial $\text{HC}_2\text{H}_3\text{O}_2$; insol. in concd. H_2SO_4 .

Au₂S, *gold sulfide, aurous sulfide*. Gray or brownish black powder; sol. in water when freshly pptd. but insol. after drying; insol. in $\text{KOH} + \text{Aq}$, dil. HCl and H_2SO_4 ; sol. in aqua regia and in $\text{Br}_2 + \text{Aq}$; easily sol. in alkaline polysulfide solns.

Au₂S₃, *gold sulfide, auric sulfide*. Brown ppt.; insol. in water, ether and acids; sol. in aqua regia; sol. in $\text{KOH} + \text{Aq}$ and alkaline sulfides.

AuS or **Au₂S₂** or **Au₂S.Au₂S₃**, *gold sulfide, auro-auric sulfide*. Black powder; decomp. by heat; insol. in water and all acids; sol. in aqua regia; sol. in alkaline polysulfide solns.

Hafnium

Hf, *hafnium*. At one time called *celtium*; see celtium; At. No. 72; At. Wt. 178.6; M. P. (1700°); B. P. $>3200^\circ$.

HfO₂, *hafnium oxide*. M. P. 2812° ; sp. gr. 9.7.

Other *hafnium compounds* are unknown or of doubtful existence.

Helium

He, *helium*. Colorless gas; may be liquefied; its boiling point is very low, somewhere near that of hydrogen; less sol. than A in water; least sol. of all known gases; sp. gr. 1.98; At. No. 2; At. Wt. 4.00; Mol. Wt. probably the same; molecule is monatomic; val. 0; does not unite with other elements; M. P. -272.2° ; B. P. -268.9° ; critical temp. is perhaps -268° ; critical pressure is 2.75 atmospheres.

Helium compounds are unknown.

Holmium

Ho, *holmium*. One of the rarest of the metals of the rare earth group; aq. solns. of the salts are pale yellow; At. No. 67; At. Wt. 163.4; val. 3.

Holmium bromide is unknown.

Holmium carbonate is unknown.

HoCl₃, *holmium chloride*. Known.

Ho(OH)₃, *holmium hydroxide, holmium hydrate*. Ppt.; insol. in water.

Ho(NO₃)₃, *holmium nitrate*. Known.

Ho₂O₃, *holmium oxide, holmia*. Pale yellow powder; insol. in water; sol. in acids to solns. which produce yellow or orange colored salts.

Ho₂(SO₄)₃, *holmium sulfate*. Known.

H₂S₃, *holmium sulfide*. Unknown.

H, hydrogen. Colorless, odorless, tasteless gas; lightest substance known; good conductor of electricity; conducts heat better than any other gas; diffuses more readily than any other gas; occluded by many metals; combines directly with the halogens and some other non-metals; does not support combustion; strong reducing agent; forms explosive mixture with air; unites with many metals, forming hydrides; sl. absorbed by water; burns in air with a blue flame to form water; may be liquefied under 40 atmospheres pressure and a temp. of -220° to a colorless liquid that boils at -252.7° and solidifies at -257° ; At. No. 1; At. Wt. 1.0077; Mol. Wt. 2.0154; sp. gr. 0.069; val. 1; 1 liter of H_2 weighs 0.08987 g.; 1 isotope; sp. gr. of liquid H_2 is 0.07, of solid 0.08; M. P. -259.1° .

HBr, hydrogen bromide; v. hydrobromic acid under Acids.

H_2CO_3 , hydrogen carbonate; v. carbonic acid under Acids.

HCl, hydrogen chloride; v. hydrochloric acid under Acids.

$H-OH$, hydrogen hydroxide; v. H_2O , water, below.

HNO_3 , hydrogen nitrate; v. nitric acid under Acids.

H_2O , hydrogen oxide, hydrogen monoxide, water. Colorless, odorless, tasteless liquid; solidifies at 0° ; vaporizes at 100° ; sp. gr. 1 at 4° ; may be cooled below 0° without freezing, if in vacuum, or if covered with oil, or if it has air dissolved in it; contracts when cooled till 4° is reached, at which temp. 1 cc. of water weighs exactly 1 g.; below 4° it expands till the freezing point is reached; 1 cc. of ice weighs 0.916 g.; ice is a poor conductor of heat and electricity; crystals are hexagonal and when separate, as in snow flakes, infinite in variety and beauty; water 2 meters or more in thickness is often bluish, but color may be due to suspended matter; poor conductor of heat; vaporizes at all temps.; 1 cc. of water forms 1696 cc. of steam; the spheroidal shape assumed by water thrown on hot metals is probably due to the layer of steam formed between the two, allowing the high surface tension of water to make itself manifest; unites with many oxides (anhydrides), forming sol. hydroxides or acids; dissolves some elements and many compounds, usually with a lowering of the freezing point; certain salts lower the temp., others raise it, when dissolved therein.

H_2O_2 , hydrogen oxide, hydrogen peroxide, hydrogen dioxide, oxygenated water, perhydrol. Known mostly in aq. soln. as a colorless liquid with harsh, bitter taste; decomp. easily to H_2O and O_2 ; sol. in water in all proportions; not stable in concd. solns.; miscible with alcohol and with ether; decomp. explosively when it contains impurities; pure H_2O_2 is colorless and syrupy, of sp. gr. 1.44, and boils at 84° under 68 mm. pressure; strong oxidizer and bleacher; liberates 1 from KI.

H_2SO_4 , hydrogen sulfate; v. sulfuric acid under Acids.

H_2S , hydrogen sulfide; v. hydrogen sulfide under Acids.

Il, illinium. One of the metals of the rare earth group; the latest element, at the present writing (1926), to be discovered; the only one discovered by an American, Dr. B. S. Hopkins of the University of Illinois; closely associated with neodymium; At. No. 61; val. probably 3.

No illinium compounds have yet been reported.

In, indium. Silver-white, lustrous, ductile metal; softer than Pb; non-cryst.; paper is blackened when rubbed with it; less volatile than Zn and Cd; stable in air at ordinary temp.; when strongly heated it burns to In_2O_3 , with bluish violet flame and brownish fumes; does not decomp. hot water; sol. in acids with evolution of H_2 ; insol. in liquid NH_3 ; insol. in $KOH + Aq$; unites directly with the halogens and S; forms alloys with certain metals; insol. in $HC_2H_3O_2$; At. No. 49; At. Wt. 114.8; Mol. Wt. unknown; sp. gr. 7.3; val. 1 and 3; M. P. 155° ; B. P. $>1450^{\circ}$; 1 isotope.

$InBr$, indium bromide, indium monobromide. Easily sol. in acids; decomp. by hot water.

$InBr_2$, indium bromide, indium dibromide. Easily sol. in acids; decomp. by hot water.

$InBr_3$, indium bromide, indium tribromide. White cryst. tablets; deliq. and sol. in water.

$In_2(CO_3)_3$, indium carbonate. White, gelatinous ppt.; insol. in water; sol. in $(NH_4)_2CO_3 + Aq$, but reprecipitated by boiling; insol. in $Na_2CO_3 + Aq$ and $KOH + Aq$.

$InCl$, indium chloride, indium monochloride. Reddish black, glassy, cryst. masses; deliq.; melts to a dark red liquid; volatile; decomp. by water into In and $InCl_3$.

$InCl_2$, indium chloride, indium dichloride. White radiated cryst.; deliq.; decomp. by water into In and $InCl_3$.

Hydrogen

Illinium

Indium

NON-METALS AND RARE METALS

Indium Cont

InCl_3 , *indium chloride, indium trichloride*. White, lustrous tablets; very deliq.; sol. in water, but decomp. when the soln. is heated; vaporizes at 600° ; sp. gr. 4.

$\text{In}(\text{OH})_3$, *indium hydroxide, indium hydrate*. Heavy, white, gelatinous ppt.; decomp. to In_2O_3 when heated; insol. in water and NH_4OH ; easily sol. in $\text{KOH} + \text{Aq}$ or $\text{NaOH} + \text{Aq}$; sol. in acids.

$\text{In}(\text{NO}_3)_3$, *indium nitrate*. Large, needle-shaped cryst. when hydrated; very deliq.; sol. in alcohol; sol. in water, the soln. pptg. a basic salt when boiled.

In_2O_3 , *indium oxide, indium monoxide*. Light, loose, black powder that oxidizes easily to In_2O_5 ; slowly sol. in acids.

In_2O_5 , *indium oxide, indium sesquioxide*. Heavy, yellow powder; becomes brown when heated but turns yellow when cold; infusible and non-volatile; slowly sol. in cold, easily in hot acids; heating to high temp. decreases its solubility in acids; less fusible than Al_2O_3 ; sp. gr. 7.17.

Other oxides are said to exist.

$\text{In}_2(\text{SO}_4)_3$, *indium sulfate*. White, very hygroscopic powder; sol. in water, but ppts. a basic salt on heating; forms an alum with $(\text{NH}_4)_2\text{SO}_4$ and double sulfates, not alums, with other alkaline sulfates; sp. gr. 3.4.

In_2S_3 , *indium sulfide, indium sesquisulfide*. Yellowish gray solid or yellow ppt.; infusible; burns to In_2O_3 when heated in air; sol. in acids; partially sol. in $(\text{NH}_4)_2\text{S} + \text{Aq}$.

InS and In_2S are said to exist.

Iodine

$\text{I}(\text{J})$, *iodine*. Grayish black, soft solid with metallic luster; or rhombic, scale-like cryst.; only the thinnest plates are transparent; very easily vaporized to a violet vapor that attacks the skin and mucous membrane; sl. sol. in water; easily sol. in alcohol, ether, chloroform and CS_2 ; solutions of I in CS_2 and chloroform are violet, those in ether and alcohol are reddish brown; sol. in many other organic liquids; easily sol. in dil. $\text{HI} + \text{Aq}$; sol. in solns. of sol. iodides; sol. in H_2SO_4 with decomp.; concd. H_2SO_4 , HCl , HNO_3 , H_3PO_4 and $\text{HC}_2\text{H}_3\text{O}_2$ dissolve I, but give it up to CS_2 on shaking therewith; At. No. 53; At. Wt. 126.932; Mol. Wt. 253.864; sp. gr. 4.93; val. 1; M. P. 113.5° ; B. P. 184° ; 1 isotope.

IBr , *iodine bromide, iodine monobromide*. Dark gray cryst.; resembles I; odor resembles that of Br; vapor attacks eyes and mucous membrane; vapor is red in thick layers; slowly sol. in water with separation of I; sol. in alcohol, ether and CS_2 ; M. P. c. 42° ; sp. gr. 4.4.

IBr_3 , *iodine bromide, iodine pentabromide*. Dark brown liquid; sol. in water, but with decomp. in sunlight; sol. in alkali solns., forming bromides and iodates.

Iodine carbonate is of doubtful existence.

ICl , *iodine chloride, iodine monochloride*. Reddish brown, oily liquid, or hyacinth red cryst. masses; odor resembles that of both I and Cl; attacks mucous membrane vigorously; sol. in alcohol, ether, CS_2 and dil. HCl ; decomp. by water; M. P. 13° to 27° ; sp. gr. 3.2.

ICl_3 , *iodine chloride, iodine trichloride*. Citron yellow, cryst. solid; deliq.; very disagreeable odor; attacks eyes and mucous membrane; decomp. in air, or even in Cl_2 , to ICl and Cl_2 at 25° ; sol. in water with decomp.; sol. in concd. H_2SO_4 ; sol. in ether and alcohol; M. P. c. 33° ; sp. gr. 3.1.

Iodine hydroxide is of doubtful existence.

Iodine nitrate is of doubtful existence.

I_2O_5 , *iodine oxide, iodine pentoxide, iodine anhydride*. White, cryst. solid; melts at c. 300° with decomp. to I_2 and O_2 ; sol. in water to form HIO_3 ; sol. in dil. alcohol; insol. in abs. alcohol, ether and CS_2 ; sp. gr. 4.79.

IO_2 and I_2O_3 are said to exist.

$\text{I}_2(\text{SO}_4)_3$, *iodine sulfate*. Ppt.; decomp. by water.

IS_2 , *iodine sulfide*. Better known as *sulfur iodide*; see *sulfur iodide* under Sulfur.

Iridium

Ir , *iridium*. Gray powder; or spongy mass; or white, hard, lustrous masses resembling steel; brittle when cold, somewhat malleable at red heat; the foil absorbs H_2 ; colloidal Ir is red to black, depending on the method of preparation; acts as a catalytic agent, but not as well as Pt; considered the most "noble" of the Pt metals; forms alloys with Pt and Os; harder than Fe; insol. in water; insol. in all acids, including aqua regia, except when in finely divided state, as "iridium black," when it is sol. in aqua regia; does not oxidize when heated in air; At. No. 77; At. Wt. 193.1; Mol. Wt. unknown; val. 2, 3 and 4; sp. gr. 22.4; M. P. 2350° ; B. P. $>4800^\circ$.

IrBr_3 , *iridium bromide, iridium tribromide*. Olive green cryst. when containing

cryst. water; sol. in water to a greenish soln. which turns blue; insol. in alcohol and ether.

IrBr_4 , *iridium bromide, iridium tetrabromide, iridic bromide*. Blue cryst. mass.; compn. is probably $\text{IrBr}_2 \cdot 2\text{HBr}$; easily sol. in water and alcohol.

Iridium carbonate is of doubtful existence.

IrCl , *iridium chloride, iridium monochloride*. Decomp. at 789° ; sp. gr. 10.18.

IrCl_2 , *iridium chloride, iridium dichloride, iridosochloride, iridous chloride*. Blackish green solid, insol. in alkalis and acids; decomp. at 773° .

IrCl_3 , *iridium chloride, iridium trichloride, iridochloride*. Olive green solid; the hydrated salt is sol. in water to a green soln.; the anhydrous salt is insol. in water, acids or alkalis; decomp. at 703° ; sp. gr. 5.3.

IrCl_4 , *iridium chloride, iridium tetrachloride, iridichloride, iridic chloride*. Black masses; translucent and dark red at edges; very deliq.; decomp. when heated; easily sol. in water.

$\text{Ir}(\text{OH})_3$, *iridium hydroxide, iridium trihydroxide, iridium hydrate*. Greenish yellow ppt.

$\text{Ir}(\text{OH})_4$, *iridium hydroxide, iridium tetrahydroxide, iridium hydrate*. Blue ppt.; sol. in dil. HCl , $\text{NaOH} + \text{Aq}$ and $\text{KOH} + \text{Aq}$; insol. in dil. H_2SO_4 and HNO_3 .

$\text{Ir}(\text{NO}_3)_3$, *iridium nitrate*, is said to exist.

IrO , *iridium oxide, iridium monoxide, iridous oxide*. Black powder.

IrO_2 , *iridium oxide, iridium dioxide, iridic oxide*. Black powder, or fine needles with metallic luster; very sl. sol. in acids.

Ir_2O_3 , *iridium oxide, iridium sesquioxide, irido-iridic oxide*. Hard, blue-black powder; decomp. at c. 1000° to Ir and O_2 ; insol. in acids; insol. in $\text{KOH} + \text{Aq}$.

$\text{Ir}(\text{SO}_4)_2$, *iridium sulfate, iridic sulfate*. Amorph. brown powder; sol. in water to a yellow soln.

$\text{Ir}_2(\text{SO}_4)_3$, *iridium sulfate, iridium sesquisulfate*. Yellow or violet solid; sol. in alcohol and water; forms alums with alkaline sulfates.

IrS , *iridium sulfide, iridium monosulfide, iridous sulfide*. Blue black solid; insol. in water.

Ir_2S_3 , *iridium sulfide, iridium sesquisulfide*. Brownish black powder; insol. in water.

IrS_2 , *iridium sulfide, iridium disulfide, iridic sulfide*. Black or brown powder; insol. in water and nitric acid.

Kr, *krypton*. Gas; less volatile than **A**; one of the inert gases existing in small quantity in the air; At. No. 36; At. Wt. 82.9; M. P. -169° ; B. P. -151.8° ; sp. gr. liquid 2.6; 6 isotopes; val. 0; when sparked electrically in a vacuum tube it gives a yellowish green glow which is said to exist in the aurora borealis (northern lights).

Kr compounds are thus far unknown.

La, *lanthanum, lanthanum*. White or grayish, malleable, ductile metal; harder than **Ce**; a metal of the rare earth group; the salt solns. are colorless; oxidizes rapidly in dry air; but burns only at higher temp. than that at which **Ce** burns; burns in Cl_2 , burns less brightly in Br_2 , and unites with I_2 without producing light; decomp. cold water slowly, hot rapidly; sol. in dil. acids; easily attacked by cold, concd. HNO_3 ; not acted on by cold, concd. H_2SO_4 ; At. No. 57; At. Wt. 138.91; Mol. Wt. unknown; sp. gr. 6.15; val. 3; M. P. 826° ; B. P. 1800° .

$\text{LaBr}_3 \cdot 7\text{H}_2\text{O}$, *lanthanum bromide*. Colorless cryst.; easily sol. in water and alcohol; sl. sol. in abs. alcohol; insol. in ether; forms double bromides.

$\text{La}_2(\text{CO}_3)_3 \cdot 8\text{H}_2\text{O}$, *lanthanum carbonate*. Small, four-sided plates, or white gelatinous ppt. which changes to cryst. scales; insol. in water, acetone and $(\text{NH}_4)_2\text{CO}_3 + \text{Aq}$; sl. sol. in $\text{CO}_2 + \text{Aq}$.

LaCl_3 , *lanthanum chloride*. Cryst. masses; deliq.; insol. in acetone; forms double chlorides; M. P. 907° ; sp. gr. 3.9.

$\text{La}(\text{OH})_3$, *lanthanum hydroxide, lanthanum hydrate*. Voluminous, snow-white powder, or gelatinous, alkaline ppt.; insol. in water; easily sol. in acids; insol. in $\text{NaOH} + \text{Aq}$ and $\text{KOH} + \text{Aq}$; absorbs CO_2 from the air; expels NH_3 from NH_4 salts.

$\text{La}(\text{NO}_3)_3 \cdot 6\text{H}_2\text{O}$, *lanthanum nitrate*. Large, prismatic cryst.; deliq.; easily sol. in water and alcohol; sol. in acetone; forms double nitrates; melts at c. 40° without decomp., but forms a basic salt at higher temp.

La_2O_3 , *lanthanum oxide, lanthanum sesquioxide*. White amorph. powder or rhombic prisms; combines with water producing the hydroxide and raising the temp.; insol. in acetone; easily sol. in acids; sol. in $\text{NH}_4\text{Cl} + \text{Aq}$ and $\text{NH}_4\text{NO}_3 + \text{Aq}$, but not in $(\text{NH}_4)_2\text{CO}_3 + \text{Aq}$; M. P. $>2000^\circ$; sp. gr. 6.5.

Iridium
Cont.

Krypton

Lan-
thanum

NON-METALS AND RARE METALS

Lan-
thanum
Cont.

La₂O₃, *lanthanum oxide, lanthanum peroxide*. Insol. in water; loses O on drying; sol. in HCl, HNO₃, H₂SO₄ and dil. HC₂H₃O₂ with decomp.

La₂(SO₄)₃·9H₂O, *lanthanum sulfate*. Large, lustrous, hexagonal prisms; sol. in water, more in cold than in hot, 3 g. in 100 g. of water at 0°, 1.9 g. at 30°, 0.69 g. at 100°; forms double sulfates; sp. gr. 2.82.

La₂S₃, *lanthanum sulfide*. Yellow masses or small, reddish yellow cryst.; decomp. by water to La(OH)₃ and H₂S; decomp. by acids.

LaS₂, *lanthanum sulfide, lanthanum disulfide*. Said to exist.

Lutecium

Lu, *lutecium*. Formerly known as *cassiopeium*, **Cp**; one of the metals of the rare earth group; very rare; salt solns. are colorless; has not yet been prepared pure; At. No. 71; At. Wt. 175.0; val. 3.

Lutecium bromide and lutecium carbonate are of doubtful existence.

LuCl₃, *lutecium chloride, lutecium trichloride*. Probably more volatile and more sol. than the Yb salt; M. P. 916°; sp. gr. 3.9.

Lutecium hydroxide is of doubtful existence.

Lu(NO₃)₃, *lutecium nitrate*. More sol. than the Yb salt.

Lu₂O₃, *lutecium oxide, lutecia*. Known, but color is uncertain; probably colorless.

Lu₂(SO₄)₃, *lutecium sulfate*. Cryst. with 8H₂O.

Lu₂S₃, *lutecium sulfide*. Of doubtful existence.

Masurium

Ma, *masurium*. One of the more recently discovered elements; At. No. 43; M. P. (2300°).

Masurium compounds are unknown.

Molyb-
denum

Mo, *molybdenum*. Gray powder with metallic luster, or hard, silver-white metal; unchanged in air at ordinary temp.; when heated it becomes brown, then blue, then white on the surface, and at high temp. it burns to MoO₃; infusible at white heat; malleable when pure, but brittle when impure; vaporizes at high temp.; forms alloys and amalgams; combines directly with S, N, P, B, and C; resembles Cr in general properties; insol. in KOH+Aq and in liquid NH₃; oxidized by hot concd. H₂SO₄ or Cl₂+Aq; unites with Cl and Br, but not with I; sol. in fused KOH, KNO₃, KClO₃ or Na₂O₂; not attacked by HCl, HF or dil. H₂SO₄; sol. in concd. H₂SO₄; very easily sol. in aqua regia; oxidized by HNO₃ either to Mo oxide, which dissolves in HNO₃, or, if HNO₃ is in excess, to molybdic acid, which remains insol.; At. No. 42; At. Wt. 96.0; Mol. Wt. unknown; sp. gr. 10.2; M. P. 2620°; B. P. 3700°; val. 2, 3, 4, 5 and 6.

MoBr₂, *molybdenum bromide, molybdenum dibromide, molybdous bromide*. Golden yellow powder; not affected by heat; insol. in water and all acids; sol. in alcohol; decomp. by alkaline solns.

MoBr₃, *molybdenum bromide, molybdenum tribromide, molybdo-molybdic bromide*. Blackish green masses or small cryst.; sublimes with difficulty; decomp. at high heat; decomp. by alkaline solns.; insol. in water, concd. HCl and cold concd. HNO₃.

MoBr₄, *molybdenum bromide, molybdenum tetrabromide, molybdic bromide*. Black, deliq., lustrous needles; easily decomp. by heat; fusible and volatile, forming brown vapors; sol. in water.

Molybdenum carbonate is of doubtful existence.

MoCl₂, *molybdenum chloride, molybdenum dichloride, molybdous chloride*. Dull yellow, amorph. powder; decomp. by heat; volatilizes with difficulty; insol. in water; sol. in alcohol and ether; sol. in dil. acids and in solns. of hydroxides.

MoCl₃, *molybdenum chloride, molybdenum trichloride, molybdo-molybdic chloride*. Dark brownish red, cryst. solid; resembles red P; decomp. by heat; insol. in water, but decomp. when heated; insol. in dil. HCl; sol. in hot dil. HNO₃ and concd. H₂SO₄; decomp. by NH₄OH, KOH+Aq and NaOH+Aq.

MoCl₄, *molybdenum chloride, molybdenum tetrachloride, molybdic chloride*. Brown, semi-cryst. solid; vapor is strongly yellow; deliq. to a brown liquid; sol. in water with a hissing sound and evolution of heat; sl. sol. in ether and alcohol; sol. in dil. H₂SO₄ and concd. HNO₃; sol. in HCl.

MoCl₅, *molybdenum chloride, molybdenum pentachloride*. Black, cryst., lustrous mass; sometimes greenish; deliq. to a brown liquid; vapor is dark red; M. P. 194°; B. P. 268°; decomp. when heated; fumes in air; sol. in water with decomp.; soln. is brown when concd., but colorless when dil.; sol. in ether and alcohol to green solns.; sol. in HCl.

Mo(OH)₃, *molybdenum hydroxide, molybdenum dihydroxide, molybdenum hydrate*. Black ppt. of indefinite compn., slowly sol. in water; sol. in acids; sol. in KOH+Aq and NaOH+Aq, but insol. in alkaline carbonate solns.

Mo(OH)₃, *molybdenum hydroxide, molybdenum trihydroxide, molybdenum hydrate*. Brown or black ppt.; decomp. when heated; oxidizes in air; difficultly sol. in acids; insol. in solns. of K₂CO₃ and of alkaline hydroxides.

Mo(OH)₄, *molybdenum hydroxide, molybdenum tetrahydroxide, molybdic hydroxide, molybdenum hydrate*. Dark red ppt.; resembles Fe(OH)₃; sl. sol. in water; forms colloidal solns.

Mo(NO₃)₄, *molybdenum nitrate*. Sol. in dil. HNO₃.

MoO, *molybdenum oxide, molybdenum monoxide, molybdous oxide*. Known only as the hydrated oxide, MoO.xH₂O; see *molybdenum hydroxide*.

Mo₂O₃, *molybdenum oxide, molybdenum sesquioxide, molybdo-molybdic oxide*. Black solid or brassy yellow cryst.; burns to MoO₃ when heated in air; insol. in water, acids and alkalis.

MoO₃, *molybdenum oxide, molybdenum dioxide, molybdic oxide*. Dark brown powder with purple tinge, or copper red to grayish, very lustrous, metal-like prisms with violet reflection; oxidizes to MoO₄ by HNO₃ or when heated in air; sl. sol. in concd. H₂SO₄; insol. in HCl, HF and KOH; sp. gr. 4.5.

MoO₃, *molybdenum oxide, molybdenum trioxide, molybdic anhydride*. White, light, porous solid, that separates into small, thin, lustrous scales when thrown into water; when heated it forms colorless or yellow, lustrous, rhombic needles; melts at red heat to a dark yellow liquid which solidifies to a yellowish white cryst. mass; sublimes at higher temp.; sl. sol. in water, more in cold than in hot, to an acid, metallic tasting, liquid, which probably contains *molybdic acid*, H₂MoO₄, and forms a series of salts called *molybdates*; sol. in acids, but insol. after ignition; M. P. 795°; sp. gr. 4.5.

Mo₂O₅, *molybdenum oxide, dimolybdenum pentoxide*. Dark violet powder; insol. in HCl and H₂SO₄.

Other oxides are said to exist.

Several *molybdenum sulfates* of varying compn. have been described; probably sol. in water and probably basic salts.

MoS₂, *molybdenum sulfide, molybdenum disulfide*. Black, lustrous powder; scales or prisms when native, resembling graphite and streaking paper; insol. in water; easily sol. in aqua regia; sol. in concd. H₂SO₄, evolving SO₂ and forming a blue liquid; forms MoO₃ when heated in air or with HNO₃; insol. in NaOH + Aq; one of the most stable of the Mo compounds; M. P. 1195°; sp. gr. 4.8.

MoS₃, *molybdenum sulfide, molybdenum trisulfide, thiomolybdic anhydride*. Black powder; turns red brown when wet; forms MoS₂ when heated; insol. in water; easily sol. in alkaline sulfide solns., forming red solns. containing sol. thio- salts.

MoS₄, *molybdenum sulfide, molybdenum tetrasulfide*. Cinnamon brown powder; insol. in water and acids; sol. in alkaline sulfide solns.

Mo₂S₃, *molybdenum sulfide, molybdenum sesquisulfide*. Steel gray needles; decomp. when heated; insol. in HCl and H₂SO₄; sol. in hot concd. HNO₃ and aqua regia.

Nd, *neodymium*. One of the two elements (the other being *praseodymium*, Pr) comprising what was at first reported as the element *didymium*, Dy; neodymium, one of the rare earth metals, is yellowish and tarnishes slowly in air; solns. of its salts are rose colored; the salts are red, rose colored, or of a violet red color; *didymium* has been described as a white or yellowish white, malleable, ductile metal; harder than Ce; oxidizes in air; burns when finely divided, producing much light; decomp. cold water slowly, hot water rapidly; insol. in cold, concd. H₂SO₄; easily sol. in dil. H₂SO₄, HCl or HNO₃; probably many of these properties apply to neodymium; likewise many of the properties ascribed to Dy compounds probably apply to Nd compounds; Nd compounds color the borax bead violet in the inner flame, but not at all in the outer flame; At. No. 60; At. Wt. 144.27; sp. gr. 6.9; M. P. 840°; val. 3; 3 isotopes.

NdBr₃, *neodymium bromide, neodymium tribromide*. Green cryst.; melt to a dark brown liquid; sol. in water.

Nd₂(CO₃)₃, *neodymium carbonate*. Light red cryst. powder; insol. in water.

NdCl₃, *neodymium chloride, neodymium trichloride*. Rose-pink, transparent cryst.; hygroscopic; sol. in water, 98 g. in 100 g. of water at 13°, 140 g. at 100°; insol. in ether; is deliq. and melts at 124° when cryst. with 6H₂O; M. P. 784°; sp. gr. 4.1.

Nd(OH)₃, *neodymium hydroxide, neodymium hydrate*. Grayish brown ppt.; insol. in water.

Nd(NO₃)₃, *neodymium nitrate*. Sol. in water and dil. HNO₃; forms double nitrates.

NON-METALS AND RARE METALS

Neodymium
Cont.

Nd₂O₃, *neodymium oxide, neodymium sesquioxide, neodymia*. Blue powder; not affected by heat; easily sol. in acids; sp. gr. 7.2.
Nd₂O₃, *neodymium oxide, neodymium dioxide*. Unstable.
 Other oxides are said to exist.
Nd₂(SO₄)₃, *neodymium sulfate*. Light red powder; sol. in water, 9 g. in 100 g. of water at 0°, 5 g. at 30°, 2.7 g. at 80°; less sol. than Pr₂(SO₄)₃.
Nd₂S₃, *neodymium sulfide, neodymium sesquisulfide*. Sp. gr. 5.1.

Neon

Ne, *neon*. One of the inert gases of the air; physical properties are not accurately known; more volatile than A; next to He and H the least condensable gas known; appears to solidify at the temp. of boiling H; gives a red glow when electrically sparked in a vacuum tube; At. No. 10; At. Wt. 20.2; monatomic; M. P. c. —248.67°; B. P. —245.9°; val. 0; 2 isotopes; critical temp. below —210°; critical pressure 29 atmospheres.

Neon compounds are thus far unknown.

Niton

Nt, *niton*. What was formerly called *niton*, Nt, is now more properly called *radon*, Rn; see *radon*.

Nitrogen

N, *nitrogen*, formerly called *azote*, **Az**. Colorless, odorless, tasteless gas; does not burn nor support combustion; very inert; combines directly with only a very few elements; combines with some metals, forming *nitrides*; combines with O under the influence of the electric spark; very sl. sol. in water; a little more sol. in alcohol; critical pressure is 35 atmospheres; critical temp. is —146°; has been liquefied at 35 atmospheres pressure and at —146° to a colorless, transparent liquid that boils at —195.8°, has a sp. gr. of 0.88, and solidifies to a snow-like mass; gaseous N₂ is very sl. sol. in water; At. No. 7; At. Wt. 14.008; Mol. Wt. 28.016; sp. gr. 0.97; val. 3 and 5; M. P. —209.86°; B. P. —195.8°; 1 isotope; sp. gr. of solid N₂ is 1.026.

NBr₃, *nitrogen bromide, nitrogen tribromide*. Red, oily liquid; strong odor; highly explosive; decomp. by water.

Nitrogen carbonate is unknown.

NCl₃, *nitrogen chloride, nitrogen trichloride*. Dark red, oily liquid; disagreeable odor; frightfully, violently, and dangerously explosive in the sunlight or in contact with organic matter; very erratic in its behavior; vaporizes, the vapor affecting the eyes and mucous membrane; decomp. by concd. HCl; insol. in water, but decomp. thereby; sol. in ether, CS₂ and CCl₄; sp. gr. 1.6.

Nitrogen hydroxide is unknown, unless hyponitrous acid, HNO, or H₂N₂O₂, might be considered the hydroxide.

Nitrogen nitrate is probably unknown, altho the formula N₂O₅ might be said to satisfy the formula NNO₃.

N₂O, *nitrogen oxide, nitrogen monoxide, nitrous oxide, laughing gas, dentists' gas, hyponitrous anhydride, hyponitrous acid anhydride*. Colorless gas with a sl. sweetish smell and taste; supports combustion almost as well as O₂; produces temporary unconsciousness when inhaled; decomp. by heat, completely at c. 900° to N₂ and O₂; has been liquefied to a colorless, very mobile liquid; sol. in cold water, insol. in hot; sp. gr. of gas is 1.5, of liquid is 0.9; M. P. —102.4°; B. P. —92°; sol. in alcohol; critical temp. is 37°; critical pressure is 77.5 atmospheres; solid N₂O is a white snow-like solid at —167°; in apparent combustion of other substances in N₂O, the substance combines with the O of the oxide and leaves the N free.

NO, *nitrogen oxide, "nitrogen dioxide," nitric oxide*. Colorless gas; combines with O immediately on exposure to air, forming brown NO₂; has been liquefied under great pressure and cold to a colorless liquid that solidifies at —167°; gaseous NO is decomp. to N₂ and O₂ at c. 1700°; sl. sol. in water; very sl. sol. in concd. H₂SO₄; less sol. in dil. H₂SO₄; sol. in concd. HNO₃; absorbed by glacial HC₂H₃O₂; very sol. in aq. solns. of ferrous salts, particularly the sulfate; easily sol. in CS₂; critical temp. is —93.5°; a blue tinge in liquid NO is probably due to the presence of higher oxides; M. P. —161°.

N₂O₃, *nitrogen oxide, nitrogen trioxide, nitrous anhydride, nitrous acid anhydride*. Pure, gaseous N₂O₃ is not known; it usually occurs as a liquid, deep blue at low temp., but yellowish green at ordinary temp.; decomp. to NO and NO₂; sol. in water at 0°; if much water is present, the soln. is quite stable at ordinary temp.; sol. in HNO₃, concd. H₂SO₄ or ether; fairly stable at —21°; B. P. —3.5°; M. P. —102°.

NO₂, *nitrogen oxide, nitrogen dioxide, nitrogen tetroxide, nitrogen peroxide*. Formula is probably N₂O₄ at low, but NO₂ at higher temp.; reddish brown gas;

choking; stains skin yellow; easily condensed to a liquid, which is colorless below 0° ; yellow at 0° to 10° , deeper yellow to nearly black as temp. rises; if water is present soln. may be green, but becomes blue on dilution and then colorless; liquid NO_2 solidifies below -10° to a white, cryst., deliq., solid; decomp. to NO and O_2 at 180° to 200° ; sol. in a very little cold water forming HNO_2 and N_2O_3 ; an excess of cold water forms HNO_2 and HNO_3 ; hot water forms HNO_2 and NO ; strong oxidizing agent; N_2O_4 changes completely to NO_2 at 150° ; M. P. -9.3° ; sol. in concd. HNO_3 , CS_2 and chloroform.

N_2O_5 , *nitrogen oxide, nitrogen pentoxide, nitric anhydride, nitric acid anhydride*. Very lustrous, colorless, translucent, rhombic prisms, or cryst. masses; melts at c. 30° with partial decomp. to NO_2 and O_2 ; boils at c. 45° ; cryst. are sometimes yellowish at c. 15° ; decomp. slowly on standing, rapidly in sunlight, giving NO_2 and O_2 ; very deliq.; combines with water to form HNO_3 ; combines with concd. HNO_3 to form fuming nitric acid; strong oxidizing agent.

Nitrogen sulfate is unknown.

N_4S_4 , *nitrogen sulfide*. Long, orange red, rhombic cryst.; odor faint at ordinary temp. but more marked at c. 120° ; vapor attacks the eyes and mucous membrane; detonates at 160° ; spontaneously explosive; explodes under concussion; insol. in water, but decomp. thereby; sl. sol. in alcohol and ether; easily sol. in CS_2 ; slowly decomp. by dil. HCl , KOH + Aq, or boiling glacial acetic acid; M. P. 178° ; sp. gr. 2.2.

Os, *osmium*. Lustrous, bluish white metal, resembling Sn, Pt and Zn; sometimes dull grayish black powder; occasionally bluish cryst. harder than glass; infusible; oxidizes easily to OsO_4 , sometimes with flame; volatile at very high temp.; the heaviest substance known; with very few exceptions it is the most infusible and least volatile of the metals; cryst. Os is insol. in aqua regia; amorph. Os is sol. in fuming HNO_3 , more slowly in aqua regia; alloys with many metals, the one with Ir being the most important; not attacked by the halogens at ordinary temp.; unites with F and Cl when heated; insol. in liquid NH_3 ; compounds show 5 degrees of oxidation; sol. in HNO_3 when finely divided and not ignited to very high temp.; when ignited it is insol. in all acids; At. No. 76; At. Wt. 190.8; Mol. Wt. unknown; val. 2, 3, 4, 6 and 8; sp. gr. 22.48; M. P. 2700° ; B. P. $> 5300^{\circ}$.

OsBr_3 , *osmium bromide, osmium tribromide*. Not known as such; but as dark brown, prismatic cryst. of $\text{Os}_2\text{Br}_7 \cdot 6\text{H}_2\text{O}$, which may be regarded as a mixture of OsBr_2 and OsBr_3 ; sol. in water.

OsBr_6 , *osmium bromide, osmium hexabromide*. See OsBr_3 .

Osmium carbonate is of doubtful existence.

OsCl_3 , *osmium chloride, osmium dichloride, osmosochloride*. Dark green, deliq. needles, or black, amorph. powder; sol. in water, the soln. being violet at first, then dark red, finally yellow.

OsCl_5 , *osmium chloride, osmium trichloride, osmo-osemic chloride, osmium sesquichloride, osmochloride*. Known usually in soln., tho it sometimes occurs as a brownish black powder; forms double chlorides; sol. in concd. H_2SO_4 , HCl , and concd. HNO_3 ; sol. in alkalies and NH_4OH ; easily sol. in alcohol; sl. sol. in ether.

OsCl_4 , *osmium chloride, osmium tetrachloride, osmic chloride, osmichloride*. Dark red powder, which when wet becomes cinnabar-red, then yellow; sol. in water to a yellow soln., which decomp. on dilution to a green soln.; forms double salts; sol. in concd. HCl .

OsCl_6 , *osmium chloride, osmium hexachloride*. Of doubtful existence; said to be a brown salt.

Os(OH)_2 , *osmium hydroxide, osmium dihydroxide, osmium hydrate*. Blue black ppt.; insol. in water; oxidizes easily in air; sol. in dil. HCl ; insol. in dil. H_2SO_4 or HNO_3 .

$\text{Os}_2(\text{OH})_4$, *osmium hydroxide, osmium sesquihydroxide, osmium hydrate*. Sol. in acids.

Other osmium hydroxides are said to exist.

Osmium nitrate is of doubtful existence.

OsO , *osmium oxide, osmium monoxide, osmous oxide*. Grayish black solid; insol. in water or acids.

OsO_2 , *osmium oxide, osmium dioxide, osmic oxide*. Grayish black powder or reddish solid; insol. in water or acids.

Os_2O_3 , *osmium oxide, osmium sesquioxide, osmo-osemic oxide*. Black powder; insol. in acids.

OsO_4 , *osmium oxide, osmium tetroxide, perosmic anhydride*, often called per-

NON-METALS AND RARE METALS

Osmium

Cont.

osmic acid, and formerly tho incorrectly called *osmic acid*. White, cryst. masses, or long, colorless, translucent, monoclinic needles; melts under 100° , and boils a few degrees above its melting point; is very volatile; sublimes easily; very disagreeable odor; poisonous; very violent action on the skin, and particularly on the eyes, causing temporary blindness; slowly but abundantly sol. in water; the aq. soln. does not react acid; sol. in alcohol and ether with gradual decomp.; sol. in NH_4OH , but soln. decomp. when heated.

OsO_3 , *osmium oxide*, *osmium trioxide*, *osmic acid*. Not known as such; may be considered the hypothetical anhydride of *osmic acid*, H_2OsO_4 , salts of which, called *osmates*, are known.

Osmium sulfate is of doubtful existence.

OsS_2 , *osmium sulfide*, *osmium disulfide*, *osmic sulfide*. Dark, brownish yellow solid; sl. sol. in water to a yellow soln.; easily sol. in HNO_3 ; sl. sol. in alkali hydroxides and solns. of alkali carbonates, less sol. after drying.

OsS_4 , *osmium sulfide*, *osmium tetrasulfide*. Brown ppt.; insol. in water; oxidizes when heated; above 100° it burns to OsO_4 and SO_2 ; insol. in solns. of alkali hydroxides, sulfides and carbonates; easily oxidized by HNO_3 .

Oxygen

O , *oxygen*; originally called *pure air*, *vital air*, *dephlogisticated air*. Colorless, tasteless, odorless gas; may be condensed at -140° and a pressure of 300 atmospheres to a mobile liquid, that is colorless in small quantities but blue in thick layers; liquid boils at -183° ; critical temp. is -118° ; critical pressure is 50 atmospheres; liquid O_2 condenses to a pale blue mass at -227° ; does not combine with P or Na at -210° , the reactivity almost ceasing at -150° ; unites with some elements slowly and quietly at ordinary temp. (oxidation), with others vigorously and with flame (combustion); it will spontaneously ignite such substances as oil and other flammable materials; certain metals, such as Pb, Fe, Cu and Ni, will ignite in it spontaneously when in extremely finely divided condition; is absorbed by molten Ag or Pt, and given off again as the metal solidifies; also absorbed by charcoal; combines directly with all elements except F, Cl, Br, I, Au and Pt; at least one binary compound of O with each element, except F and Br, is known; oxides of the positive elements as a class are basic, and those of the negative elements are acid; for further data regarding oxides, see oxides under the "Acids" group; very sl. sol. in water; sl. more sol. in alcohol; insol. in ether; At. No. 8; At. Wt. 16.000; Mol. Wt. 32.00; sp. gr. of gas 1.1, of liquid 1.12, of solid 1.426; val. 2; M. P. -218.4° ; B. P. -183° .

O_3 , *ozone*, an allotropic form of oxygen, is a colorless or bluish gas with characteristic odor; unstable, breaking down easily into molecular oxygen, O_2 ; may be condensed at -100° and under 125 atmospheres pressure to a deep blue, almost black liquid; not appreciably sol. in water but imparts its taste and properties to water; usually occurs mixed with O_2 ; acts as a strong bleaching agent on vegetable colors; a small amount of O_3 in O_2 changes the properties of Hg markedly, taking away its luster and convexity of surface; one of the most powerful oxidizing agents known; it oxidizes P, S, and As into their acids, and changes sulfides to sulfates; attacks organic compounds vigorously; liquid ozone is explosive; destroys india rubber quickly; Mol. Wt. 48; B. P. -106° .

Oxygen bromide is unknown.

Oxygen carbonate is unknown.

Oxygen chloride; see *oxides of chlorine* under **Chlorine**.

Oxygen hydroxide is unknown.

Oxygen nitrate is unknown.

Oxygen oxide is unknown, unless molecular oxygen, O_2 , might possibly be considered as oxide of oxygen; see similar conditions under *chlorine chloride* and *bromine bromide*; in this case ozone, too, might possibly be considered as oxide of oxygen.

Oxygen sulfate is unknown.

Oxygen sulfide; see *sulfur dioxide* and *sulfur trioxide* under **Sulfur**.

Palladium

Pd , *palladium*. Gray, metallic sponge that can be pressed together, more easily than Pt, to a compact mass; compact Pd may also be made by melting spongy Pd; Pd is a white, fairly malleable, ductile metal, similar to Ag and Pt; hard metal, but a little softer than Pt; can be polished and hammered into thin plates; occurs occasionally in cryst. form, octahedral or tabular; volatilizes in the oxy-hydrogen flame at c. 2000° to greenish vapors, which condense to a brownish sublimate, consisting of a mixture of the metal and the oxide; when heated in air or oxygen Pd is oxidized superficially to PdO , but this oxide is reduced to Pd and O_2 at higher temp.; when heated in an alcoholic flame "Pd

black" absorbs much C and increases in volume; Pd absorbs much H_2 at c. 100° , possibly with formation of a hydride; colloidal Pd absorbs gases easily; not tarnished in dry or moist air or in ozone; combines with the halogens, As and S at high temp.; insol. in liquid NH_3 ; not attacked by water; more easily sol. in acids than the other Pt metals; sl. sol. in dil. HCl, but Pd sponge or filings are easily sol. in warm HCl, access of air or Cl_2 , giving $PdCl_2$; easily sol. in HNO_3 , even when cold; easily sol. in aqua regia; sol. in hot, concd. H_2SO_4 ; sl. sol. in concd., but insol. in dil. $HI + Aq$; sol. in $HBr + Aq$ if a trace of HNO_3 is present; At. No. 46; At. Wt. 106.7; Mol. Wt. unknown; sp. gr. 12; val. 1, 2, and 4; M. P. 1555° ; B. P. 2200° .

$PdBr_2$, *palladium bromide, palladium dibromide, palladous bromide, palladious bromide, palladoso-bromide*. Chestnut brown masses; insol. in water; sol. in HBr ; with bromides of the alkali metals it forms double salts, called *palladio-bromides* or *bromopalladites*.

$PdBr_4$, *palladium bromide, palladium tetrabromide, palladic bromide*. Not known as such, but as double salts with the alkali bromides; these are called *palladiobromides* or *bromopalladates*, and are salts of the hypothetical H_2PdBr_4 .

$PdCO_3$, *palladium carbonate, palladous carbonate, palladious carbonate*. Insol. in water; sol. in acids; sl. sol. in $NaOH + Aq$.

$PdCl$, *palladium chloride, palladium monochloride, palladium subchloride*. Dark, reddish brown, cryst. solid; deliq.

$PdCl_2$, *palladium chloride, palladium dichloride, palladous chloride, palladious chloride, palladoso-chloride*. Red brown prisms, or blackish brown cryst. solid, or garnet red sublimates; sol. in water to a dark red soln.; sol. in acetone; forms double salts called *palladiochlorides* or *chloropalladites*; M. P. 500° .

$PdCl_4$, *palladium chloride, palladium tetrachloride, palladic chloride, palladi-chloride*. Not known as such, but as double salts with chlorides of the alkali metals, called *palladichlorides* or *chloropalladates*.

$Pd(OH)_2$, *palladium hydroxide, palladium dihydroxide, palladous hydroxide, palladious hydroxide, palladium hydrate*. Dark brown ppt. of indefinite compn.; insol. in water; sol. in acids; sol. in alkaline hydroxide solns. and alkaline carbonate solns.

$Pd(OH)_4$, *palladium hydroxide, palladium tetrahydroxide, palladic hydroxide, palladium hydrate*. Red or brown ppt. of indefinite compn.; sol. in acids.

$Pd(NO_3)_2$, *palladium nitrate, palladium dinitrate, palladous nitrate, palladious nitrate*. Long, yellow or brown, prisms; very deliq.; sol. in water with pptn. of a basic salt.

Pd_2O , *palladium oxide, palladium suboxide*. Black powder; decomp. to Pd and O_2 at red heat; reduced by H at ordinary temp.; decomp. by acids into palladous salts with separation of Pd.

PdO , *palladium oxide, palladium monoxide, palladous oxide, palladious oxide*. Black powder; decomp. to Pd and O_2 at red heat; slowly sol. in boiling acids; oxidizes organic substances strongly; decomp. at 877° .

PdO_2 , *palladium oxide, palladium dioxide, palladic oxide*. Black powder; decomp. to PdO and O_2 at low red heat, but to Pd and O_2 at full red heat; sl. attacked by acids, most easily by HCl.

Pd_2O_3 or $4PdO.PdO_2$, *palladium oxide, pallado-palladic oxide*. Dull brown powder; decomp. to Pd and O_2 at red heat; not attacked by aqua regia.

Pd_2O_3 , *palladium oxide, palladium sesquioxide*. Brown ppt.; insol. in water; sol. in HCl.

$PdSO_4$, *palladium sulfate, palladous sulfate, palladious sulfate*. Indistinct, olive green, cryst.; deliq.; sol. in water with pptn. of a brown basic salt.

Pd_2S , *palladium sulfide, palladium subsulfide*. Hard, gray or green, solid; stable in air; insol. in water and acids; sl. sol. in aqua regia; M. P. 800° with decomp.

PdS , *palladium sulfide, palladium monosulfide, palladous sulfide, palladious sulfide*. Bluish white, lustrous, very hard, metal-like solid, or black amorph. powder; oxidizes to sulfate when heated; insol. in water; sol. in dil. HCl; M. P. 950° .

PdS_2 , *palladium sulfide, palladium disulfide, palladic sulfide*. Dark brown powder or reddish brown needles with metallic luster; sl. sol. in dil. HNO_3 ; sol. in aqua regia.

P, *phosphorus*. Occurs in three allotropic forms,—yellow, red and cryst.

Yellow phosphorus, ordinary phosphorus, octahedral phosphorus, stick phosphorus, white phosphorus, crystalline phosphorus. Semi-transparent, colorless, cryst. solid; characteristic odor, due probably to ozone and P_2O_3 ; when melted

Phosphorus
Cont.

and cooled quickly P is opaque, when cooled slowly it is nearly as clear as water; melted in large quantity and allowed to cool slowly, fairly large octahedral or dodecahedral cryst. are formed; must be kept under water; if water is free from air the P remains transparent; in ordinary water the P is covered with a whitish film or turns red; soft as wax at ordinary temp., but brittle when cooled; turns yellow, then red, on surface when exposed to light; sublimes easily in a vacuum or an indifferent gas; melts at 44.1° , and often remains liquid many degrees below the M. P.; may be obtained in finely divided particles by melting it under water, and shaking carefully till the P solidifies; non-conductor of electricity; vapor is colorless; molecule is P_4 between 500° and 1000° , but P_2 at temps. above 1500° ; sol. in S_2Cl_2 , CCl_4 , liquid SO_2 , liquid NH_3 , PCl_3 , PCl_5 , and PBr_3 ; sl. sol. in ether, alcohol and acetone; ignition point is 45° in the air; luminous in the dark at 20° or above, in contact with moist air, evolving poisonous fumes having a garlic-like odor; this luminosity, or phosphorescence, is due either to slow oxidation or to formation of spontaneously flammable PH_3 , and is not increased in pure O_2 ; decreasing the pressure increases the luminosity; must always be kept under water; combines directly with the halogens, S, Se, Te, also with most of the metals; powerful reducing agent, reducing solns. of metallic salts to the metals; does not oxidize or phosphoresce in pure dry O_2 ; is a powerful poison; insol. or only very sl. sol. in water; sl. sol. in alcohol, ether or hot, concd. $HC_2H_3O_2$; decomp. by concd. HCl at 140° to PH_3 and H_3PO_3 ; easily sol. in CS_2 , from which alcohol reprecipitates the P; sol. with decomp. in hot, concd. HNO_3 ; reacts with boiling $KOH + Aq$ or $NaOH + Aq$; volatilizes in water-vapor, even at ordinary temp.; when distilled in steam and the distillate is cooled rapidly the P is obtained as a white, snow-like mass; oxidizes very easily, slowly at low temp., more rapidly as the ignition temp., 60° , is approached; burns in air or O_2 with intense white light, production of much heat, and formation of P_2O_5 ; is changed to red P by action of light, heat or electricity, the action of heat beginning at c. 215° at ordinary pressure and being complete at 260° in the air or at 300° in a sealed tube; At. No. 15; At. Wt. 31.024; Mol. Wt. 62.048 or 124.096; probably the latter; sp. gr. 1.82; val. 3 and 5; M. P. 44.1° ; B. P. 280° .

Red phosphorus, amorphous phosphorus. Dull, dark carmine; odorless, tasteless powder; turns darker on heating, and black when boiled with $KOH + Aq$; brittle; apparently no cryst. form; no luster; does not melt when heated to redness in a sealed tube, but some vapor is formed and this solidifies to the cryst. variety; may be distilled at c. 260° , becoming cryst.; catches fire at c. 250° - 260° ; burns actively at c. 300° ; does not oxidize in dry air, but slowly in moist air; does not glow in air; is not poisonous; a mixture of red P and $KClO_3$ explodes when struck, but not as violently as yellow P and $KClO_3$; formerly thought to be non-cryst., but now known to form hexagonal cryst.; not phosphorescent; changed to black P on long heating at 360° in sealed tubes; insol. in liquid NH_3 ; sol. in S_2Cl_2 ; insol. in water, CS_2 , alcohol, ether, NH_4OH , or boiling $KOH + Aq$; concd. H_2SO_4 does not act on it in the cold, but dissolves it easily when hot; more sol. than yellow P in HNO_3 ; sp. gr. 2.2; M. P. 590° at 43 atmospheres.

Crystalline phosphorus, black phosphorus, metallic phosphorus, Hittorf's phosphorus. Long, black, thin, rhombohedral cryst. which appear red in transmitted light; metallic luster; less volatile than amorph. P; changed to ordinary P when heated in a sealed tube to c. 358° ; sol. in CS_2 ; insol. in HNO_3 and not attacked thereby; sp. gr. 2.3.

Scarlet phosphorus is a bright red, extremely finely divided variety; resembles red P; apparently amorph.; very active.

PBr_3 , phosphorus bromide, phosphorus tribromide, phosphorous bromide. Colorless, mobile liquid; very penetrating odor; fumes in air; not acted on by O_2 ; sol. in alcohol, acetone, CS_2 and liquid H_2S ; decomp. slowly by cold water, rapidly at 25° , to HBr and H_3PO_3 ; solidifies at -41° ; M. P. -40° ; B. P. 175° ; sp. gr. 2.8.

PBr_5 , phosphorus bromide, phosphorus pentabromide, phosphoric bromide, phosphorus perbromide. Citron yellow solid; fumes in air; melts to red liquid when heated; this recryst., yellow if rapid, red if slow; vaporizes to red vapors; decomp. by water violently; decomp. at 100° ; forms HBr and $POBr_3$ with a little water, but HBr and H_3PO_4 with much water.

Phosphorus carbonate is unknown.

PCl_3 , phosphorus chloride, phosphorus trichloride, phosphorous chloride. Clear, colorless, highly refractive liquid; pungent odor; fumes in air; vaporizes without decomp. to a lachrymatory vapor; non-conductor of electricity; decomp.

by alcohol; dissolves I and P; decomp. by water to HCl and H_2PO_3 , with occasional separation of P if warm; B. P. 76° ; M. P. -111.8° ; sp. gr. 1.57.

PCl_5 , phosphorus chloride, phosphorus pentachloride, phosphoric chloride, phosphorus perchloride. White or light yellow, lustrous, cryst. solid; very deliq.; strong odor; fumes in air; vapor attacks the eyes; sublimes without melting below 100° ; decomp. by heat; melts at c. 118° under pressure; boils at 160° to 165° ; non-conductor of electricity; decomp. violently by water to HCl and POCl_3 , and then H_3PO_4 .

P_2Cl_4 , phosphorus chloride, phosphorus dichloride. Said to be a colorless, oily liquid; fumes strongly; B. P. 180° .

Phosphorus hydride is unknown, unless some of the hypothetical hydrated P acids might be considered as hydroxides.

Phosphorus nitrate is unknown.

P_4O , (?) phosphorus oxide, phosphorus suboxide. Orange-red or scarlet-red powder; sl. sol. in water; unchanged in dry, gradually oxidized in moist air; insol. in alcohol, ether and HCl ; oxidized by HNO_3 or H_2SO_4 ; two modifications seem to exist; the first is decomp. slowly by water or boiling alkali solns.; the second is not so decomp.; sp. gr. 1.9.

P_4O_6 , formerly P_2O_3 , phosphorus oxide, phosphorus trioxide, phosphorous oxide, phosphorous anhydride, phosphorous acid anhydride. White, voluminous, snow-like masses, with odor somewhat resembling that of P; when melted and cooled slowly it cryst. in long, thin prisms, probably monoclinic; melts at 22.5° to a clear, colorless, very mobile liquid, which solidifies at 21° ; boils at 173° in CO_2 or N_2 ; oxidizes to P_2O_5 in the air; deliq.; very slowly sol. in cold water to form H_3PO_3 ; violently decomp. by hot water with various products; sol. without decomp. in ether or CS_2 ; sp. gr. 2.1.

P_2O_5 , phosphorus oxide, phosphorus tetroxide, phosphorosulphosphoric oxide. Colorless cryst., probably orthorhombic; very deliq., forming H_3PO_3 and H_3PO_4 ; does not melt at 100° ; volatilizes at c. 180° ; sol. in water, with evolution of heat; sp. gr. 2.5.

P_2O_5 or P_4O_{10} , phosphorus oxide, phosphorus pentoxide, phosphoric oxide, phosphoric anhydride, phosphoric acid anhydride. Amorph., white, odorless, powder or solid; melts at red heat; sublimes at higher temp.; extremely deliq.; not only absorbs moisture from the air but withdraws O and H from many compounds in the proportions to form water; does not act on litmus when perfectly dry; sol. in water, with great evolution of heat and formation of H_3PO_4 ; reduces H_2SO_4 to SO_2 and HNO_3 to N_2O_5 ; sp. gr. 2.4.

Phosphorus sulfate is unknown.

P_4S_3 , phosphorus sulfide, tetraphosphorus trisulfide, phosphorus sesquisulfide, hypophosphorous sulfide. Yellow prisms or cryst. solid; melts at 172° to a sl. colored liquid; boils at 407° with decomp.; sublimes; burns at c. 100° in air to P_2O_5 and SO_2 ; sol. in CS_2 and PCl_3 ; sol. in alcohol and ether with decomp.; oxidized by HNO_3 or $\text{KOH} + \text{Aq}$; sp. gr. 2.

P_4S_4 or P_2S_5 , phosphorus sulfide, phosphorus trisulfide, phosphorous sulfide, tetraphosphorus hexasulfide, thiophosphorous anhydride. Grayish yellow, cryst. solid; no taste and no odor; does not fume in air; sublimes more easily than S; decomp. in moist air; burns in air; sol. in alcohol, ether and CS_2 ; M. P. 290° ; B. P. 540° .

P_4S_5 or P_2S_6 or PS_3 , phosphorus sulfide, phosphorus disulfide, phosphorus tetrasulfide, triphosphorus hexasulfide. Long, clear, yellow, needle cryst.; almost insol. in CS_2 ; M. P. 298° ; B. P. 335° to 340° .

P_2S_5 or P_4S_{10} , phosphorus sulfide, phosphorus pentasulfide, phosphorus persulfide, phosphoric sulfide, thiophosphoric anhydride. Large, clear, pale yellow cryst.; burn in air to P_2O_5 and SO_2 ; decomp. in moist air; vapor is brown; very deliq.; sol. in CS_2 ; very sol. in alcohol and alkaline hydroxide solns.; decomp. alcohol; M. P. 276° to 290° ; M. P. 513° to 515° ; sp. gr. 2.

P_4S_7 , phosphorus sulfide, tetraphosphorus heptasulfide. Small, pale yellow prisms; sl. sol. in CS_2 ; M. P. 310° ; B. P. 523° ; sp. gr. 2.2.

P_2S , P_4S and P_2S_{12} are said to exist.

Pt, platinum. Occurs in three forms, cryst., amorph. and ordinary solid; the cryst. form is regular octahedral or dodecahedral cryst.; the amorph. form, called platinum black, is a porous, heavy, very finely divided, black powder, which becomes metallic, gray and lustrous when rubbed, has a sp. gr. of 17, and absorbs large quantities of gases easily; ordinary Pt is a white metal with a grayish tinge; very stable in air; softer than Ag and Cu; has no taste or odor; very malleable and ductile; takes good polish; has high permanent luster; most

Platinum

NON-METALS AND RARE METALS

Platinum Cont.

easily fused of Pt metals except Pd; melts at 1755° , but becomes soft and workable much below its M. P.; occludes many times its own volume of H_2 ; absorbs O_2 when fused and "spits" when cooled quickly; a warmed Pt wire absorbs enough of H_2 or certain other gases to cause it to glow; H_2 passed over spongy Pt ignites; *spongy Pt* is finely divided Pt presenting very large surfaces to gases; *colloidal Pt* is a dark brown soln.; Pt is oxidized when fused with alkalis, peroxides or KNO_3 ; sl. sol. in $KCN + Aq$, and attacked by fused KCN ; attacked by P, As, Si, and C when fused therewith, especially in the reducing flame; forms fusible alloys with certain metals, e.g., Ag, Au, Sn, Sb, As, Cu, Pb, and Bi; hardness is increased and ductility decreased when alloyed with Ir; continued heating at red heat softens Pt; good catalytic agent, Pt sponge and Pt black being better than solid Pt; the catalytic action is not affected by the presence of Ni, but other metals decrease or destroy it; one of the most permanent and least tarnishable of metals; hot concd. H_2SO_4 attacks Pt slowly; finely divided Pt is more sol. than solid Pt in acids; attacked by Cl_2 ; poorer conductor of heat and electricity than Cu; not acted on by water, pure H_2SO_4 , HCl or HNO_3 ; slowly sol. in aqua regia; sol. in various mixtures of acids; At. No. 78; At. Wt. 195.23; Mol. Wt. unknown; sp. gr. 21.45; val. 2 and 4; M. P. 1755° ; B. P. 4300° .

$PtBr_2$, *platinum bromide, platinum dibromide, platinous bromide*. Brown powder; decomp. slowly at c. 300° ; insol. in water; sol. in $HBr + Aq$ and $KBr + Aq$.

$PtBr_4$, *platinum bromide, platinum tetrabromide, platinic bromide*. Dark brown powder; deliq.; decomp. at 180° ; very sl. sol. in water; sol. in aq. alcohol; more sol. in abs. alcohol or ether; with alkali bromides it forms double salts called *bromoplatinates*.

Platinum carbonate is unknown.

$PtCl_2$, *platinum chloride, platinum dichloride, platinous chloride, platinum-chloride*. Brown powder; decomp. at red heat; insol. in water; sol. in hot dil. HCl ; insol. in HNO_3 and H_2SO_4 ; insol. in ether, alcohol and acetone; decomp. by $KOH + Aq$; combines with many metallic chlorides forming *platio-chlorides* or *chloroplatinites*; sp. gr. 5.8.

$PtCl_3$, *platinum chloride, platinum trichloride*. Sol. in water; insol. in cold, concd. HCl , but sol. in hot.

$PtCl_4$, *platinum chloride, platinum tetrachloride, platinic chloride, platinum-chloride*. Reddish brown solid; sometimes turns yellow in moist air; not deliq., but easily sol. in water; insol. in concd. H_2SO_4 ; decomp. at red heat; sol. in alcohol, ether and acetone; combines with many metallic chlorides forming *platio-chlorides* or *chloroplatinates*.

$Pt(OH)_2$, *platinum hydroxide, platinum dihydroxide, platinous hydroxide, platinum hydrate*. Black ppt.; insol. in water; sol. in HCl , HBr and H_2SO_4 , but insol. in other oxy acids; decomp. by $KOH + Aq$.

$Pt(OH)_4$, *platinum hydroxide, platinum tetrahydroxide, platinic hydroxide, platinum hydrate*. White ppt. that changes to yellow on drying; insol. in water; easily sol. in dil. acids and $NaOH + Aq$.

$Pt(NO_3)_2$, *platinum nitrate, platinum dinitrate, platinous nitrate*. Of doubtful compn.; insol. in water.

$Pt(NO_3)_4$, *platinum nitrate, platinum tetranitrate, platinic nitrate*. Known only in soln. which decomp. on evaporation.

PtO , *platinum oxide, platinum monoxide, platinous oxide*. Violet or gray powder; reduced to Pt and O_2 at red heat; sol. in concd. H_2SO_4 ; easily sol. in concd. HCl ; sol. in molten KOH .

PtO_2 , *platinum oxide, platinum dioxide, platinic oxide*. Black powder; insol. in acids.

PtO_3 , *platinum oxide, platinum trioxide*. Brown ppt.; loses O on standing; insol. in dil. H_2SO_4 , HNO_3 and $HC_2H_3O_2$; sol. in concd. acids with decomp.

Pt_2O_3 , *platinum oxide, platinum sesquioxide*. Dark brown powder; insol. in dil. and concd. H_2SO_4 ; sl. sol. in hot dil. HNO_3 ; sol. in HCl and concd. alkaline hydroxide solns.

Pt_3O_4 , *platinum oxide, platino-platinic oxide*. Black powder; loses its O at red heat; insol. in acids; insol. even with long boiling with HCl , HNO_3 or aqua regia.

$PtSO_4$, *platinum sulfate, platinous sulfate*. Known only in soln. which is a dark syrup.

$Pt(SO_4)_2$, *platinum sulfate, platinic sulfate*. Solid; brown or almost black; sol. in dil. acids; sol. in alcohol and ether; deliq.

PtS , *platinum sulfide, platinum monosulfide, platinous sulfide*. Green or gray,

lustrous solid, or needle cryst.; black when wet; decomp. when heated; insol. in acids, aqua regia and $\text{KOH} + \text{Aq}$; sp. gr. 8.9.

PtS_2 , *platinum sulfide, platinum disulfide, platonic sulfide*. Black solid, or steel gray needles; oxidized to sulfate when heated with oxidizing agents; sol. in aqua regia; insol. in other acids; sol. in alkaline sulfide solns. when freshly pptd.; sp. gr. 5.3.

Pt_2S_3 , *platinum sulfide, platinum sesquisulfide, platino-platonic sulfide*. Steel gray, metal-like solid; insol. in acids; slowly sol. in aqua regia; sp. gr. 5.5.

Po , *polonium*. A radioactive element associated with radium; sometimes called Radium-F; At. No. 84; At. Wt. 210; M. P. (1800°).

Polonium nitrate and *polonium sulfide* are known; other compounds are of doubtful existence.

Pr , *praseodymium*. One of the two elements (the other being *neodymium*, Nd) comprising what was at first reported as the element *didymium*, Dy ; praseodymium, one of the rare earth elements, is yellowish and is not affected by air; solns. of the salts are green; the salts are also green; *didymium* has been described as a white or yellowish white, malleable, ductile metal; harder than Ce ; oxidizes in air; burns when finely divided, producing much light; decomp. cold water slowly, hot water rapidly; insol. in cold, concd. H_2SO_4 ; easily sol. in dil. H_2SO_4 , HCl or HNO_3 ; probably many of these properties apply to praseodymium; likewise many of the properties ascribed to Dy compounds probably apply to Pr compounds; Pr compounds color the borax bead yellowish green in the outer flame and green in the inner flame; At. No. 59; At. Wt. 140.92; sp. gr. 6.5; M. P. 940°; val. 3; 1 isotope.

PrBr_3 , *praseodymium bromide*. Green, cryst. powder; resembles PrCl_3 ; easily sol. in water; sol. in HBr .

$\text{Pr}_2(\text{CO}_3)_3$, *praseodymium carbonate*. Cryst. with $8\text{H}_2\text{O}$ as green silky plates.

PrCl_3 , *praseodymium chloride*. Pale green, cryst. mass or bluish green, transparent, needle cryst.; easily sol. in water and alcohol; sol. in concd. HCl ; insol. in ether and most organic solvents; cryst. with $7\text{H}_2\text{O}$; M. P. 818°; sp. gr. 4.

$\text{Pr}(\text{OH})_3$, *praseodymium hydroxide, praseodymium hydrate*. Light green, amorph. powder; insol. in water.

$\text{Pr}(\text{NO}_3)_3 \cdot 6\text{H}_2\text{O}$, *praseodymium nitrate*. Long needles; sol. in water; forms double nitrates.

Pr_2O_3 , *praseodymium oxide, praseodymium sesquioxide, praseodymia*. Light green powder; sol. in water; easily sol. in acids; sp. gr. 6.8.

Pr_2O_3 , Pr_4O_7 and PrO_2 are said to exist.

$\text{Pr}_2(\text{SO}_4)_3 \cdot 8\text{H}_2\text{O}$, *praseodymium sulfate*. Green, monoclinic cryst.; sol. in water, 19 g. in 100 g. of water at 0°, 10 g. at 35°, 1 g. at 95°; sp. gr. 2.8; other hydrated salts are known.

Pr_2S_3 , *praseodymium sulfide, praseodymium sesquisulfide*. Resembles La_2S_3 ; sp. gr. 5.

PrS_2 , *praseodymium sulfide, praseodymium disulfide*. Decomp. by heat.

Pa , *protoactinium, proactinium*. The parent of actinium; possibly the ekatan-talum of the Periodic System, or an isotope of Ta ; At. No. 91; At. Wt. doubtful; B. P. perhaps 6200°.

Protoactinium compounds are unknown.

Ra , *radium*. White metal; blackens rapidly in air, the nitride being formed; blackens white paper; reacts with water, forming the hydroxide; easily sol. in HCl ; strongly radioactive; more volatile than Ba ; temp. of Ra and of its salts is usually c. 1.5° above that of its surroundings, due to the emission of heat; 1 g. of Ra evolves sufficient energy to raise the temp. of 1 g. of water from 0° to 100° every hour; salts of radium give a carmine flame coloration; At. No. 88; At. Wt. 225.95; sp. gr. about 5; M. P. probably 960°; B. P. probably 1140°; val. 2.

RaBr_2 , *radium bromide*. Cryst.; colorless or white when pure, but sometimes colored yellow, orange or pink; resembles the corresponding Ba salt; phosphoresces blue when freshly made or in the presence of BaBr_2 ; decomp. in air to Br_2 and $\text{Ra}(\text{OH})_2$; less sol. than BaBr_2 ; cryst. with $2\text{H}_2\text{O}$, which is lost at 100°; M. P. 728°; sp. gr. 5.8.

RaCO_3 , *radium carbonate*. Amorph. powder; white when pure, but sometimes colored yellow, orange or pink; resembles BaCO_3 ; insol. in water; less sol. than BaCO_3 .

RaCl_2 , *radium chloride*. Cryst.; colorless or white when pure, but sometimes

Platinum
Cont.

Polonium

Praseo-
dymium

Proto-
actinium

Radium

NON-METALS AND RARE METALS

Radium Cont.

colored yellow, orange or pink; resembles BaCl_2 ; sl. less sol. than BaCl_2 in water and HCl ; cryst. with $2\text{H}_2\text{O}$ which is lost at 100° ; fuses when heated and then solidifies to a glassy mass which phosphoresces blue; M. P. 1000° ; sp. gr. 4.9.

$\text{Ra}(\text{OH})_2$, *radium hydroxide, radium hydrate*. White, amorph. ppt.; strongly basic; absorbs CO_2 from the air.

$\text{Ra}(\text{NO}_3)_2$, *radium nitrate*. Cryst.; colorless or white when pure, but sometimes colored yellow, orange or pink; resembles $\text{Ba}(\text{NO}_3)_2$; sol. in water.

RaO , *radium oxide*. Probably resembles BaO .

RaSO_4 , *radium sulfate*. Cryst.; white when pure, but sometimes yellow, orange or pink; resembles BaSO_4 ; less sol. than BaSO_4 .

RaS , *radium sulfide*. Probably resembles BaS .

Radon

Rn , *radon*. What was formerly called *niton*, Nt , is now more properly called *radon*; it is the radium emanation left behind when an atom of He has been driven off as an α -particle from an atom of Ra ; can be condensed to a colorless, transparent, phosphorescent liquid, which boils at -61.8° , and finally to a glowing, opaque solid, which has a steel blue phosphorescence and melts at -71° ; the solid changes to yellow and then to orange-red with a further lowering of the temp.; decomp. water, NH_3 , and HCl into their elements; decomp. CO and CO_2 ; sp. gr. of liquid is 6.8; critical temp. 104.5° ; critical pressure 47 mm.; At. No. 86; At. Wt. 222.

Radon compounds are unknown.

Rhenium

Re , *rhenium*. At. No. 75; M. P. perhaps 3000° .

Rhenium compounds are unknown.

Rhodium

Rh , *rhodium*. Very hard, white, lustrous metal with grayish blue tinge; similar to Al ; about as malleable and ductile as Ag ; melts at a higher temp. than Pt without volatilizing; spits on cooling; superficially oxidized when strongly heated in air; a powerful catalyst; more readily attacked by Cl and Br than the other Pt metals; solns. of its salts are rose red in color; sol. in aqua regia when alloyed with other metals; insol. in all acids, even aqua regia, when compact; absorbs H_2 ; Rh sponge, a black, porous solid or powder, is sol. in HNO_3 or sl. in HCl in presence of air; At. No. 45; At. Wt. 102.91; Mol. Wt. unknown; val. 3; sp. gr. 12.5; M. P. 1955° ; B. P. $> 2500^\circ$.

RhBr_3 , *rhodium bromide, rhodium tribromide*. Reddish cryst.; very sol. in water.

Rhodium carbonate is of doubtful existence.

RhCl_3 , *rhodium chloride, rhodium dichloride*. Grayish red or rose red powder; insol. in water and dil. HCl and HNO_3 ; decomp. by $\text{KOH} + \text{Aq}$.

RhCl_3 , *rhodium chloride, rhodium trichloride, rhodo-rhodic chloride, rhodium sesquichloride, rhodochloride*. Red powder, resembling sealing wax; insol. in water and acids, including aqua regia; sol. in solns. of alkalis; with alkali chlorides forms double salts called *rhodochlorides*.

$\text{Rh}(\text{OH})_3$, *rhodium hydroxide, rhodium trihydroxide, rhodium hydrate*. Black, gelatinous ppt., or heavy, dark brown mass with conchoidal fracture and metallic luster, or yellow ppt.; insol. in water; sl. sol. in acids; the yellow variety is sol. in $\text{NaOH} + \text{Aq}$ or $\text{KOH} + \text{Aq}$.

$\text{Rh}(\text{OH})_4$, *rhodium hydroxide, rhodium tetrahydroxide, rhodium hydrate*. Green ppt.; insol. in water; sol. in HCl to a blue soln.

$\text{Rh}(\text{NO}_3)_3$, *rhodium nitrate*. Dark yellow, very deliq., gummy masses; sol. in water; insol. in alcohol.

RhO , *rhodium oxide, rhodium monoxide, rhodous oxide*. Said to exist as a gray powder; insol. in acids.

RhO_2 , *rhodium oxide, rhodium dioxide, rhodic oxide*. Brown solid; insol. in acids or boiling $\text{KOH} + \text{Aq}$.

Rh_2O_3 , *rhodium oxide, rhodo-rhodic oxide*. Gray solid, or lustrous, metal-like cryst.; insol. in water, boiling $\text{KOH} + \text{Aq}$, and all acids, even aqua regia.

RhO_3 , *rhodium oxide, rhodium trioxide, rhodic acid*. Not known as such; known only in soln. of potassium rhodate which decomp. easily.

$\text{Rh}_2(\text{SO}_4)_3$, *rhodium sulfate, rhodic sulfate*. Brick red powder; easily sol. in water; decomp. by hot water to a yellow basic salt; cryst. with $12\text{H}_2\text{O}$ as a pale yellow cryst. salt; forms rhodium alums with sulfates of the alkali metals.

RhS , *rhodium sulfide, rhodium monosulfide, rhodous sulfide*. Bluish white, lustrous, solid with metallic luster; gives spongy Rh when heated in air; insol. in aqua regia.

Rh_2S_3 , *rhodium sulfide, rhodium sesquisulfide, rhodo-rhodic sulfide*. Black ppt. or cryst. plates; insol. in aqua regia.

Rubidium

Rb, *rubidium*. White, very lustrous metal, sometimes with a tinge of yellow; very similar to K; soft as wax, even at -10° ; melts easily at 38.5° ; distills to a blue vapor when heated out of O_2 to near red heat; exposed to air it is covered at once with a grayish blue film, perhaps a suboxide; much heat is produced and the metal soon takes fire, burning to the oxide; is more easily fusible and more volatile than K; has greater attraction for O than has K; Rb salts are similar to K salts, but more sol., and tend to form double salts; the metal may be distilled out of air; burns with a violet flame; unites directly with Br and Cl with flame; decomp. cold water violently and rapidly, the H_2 burning; insol. in hydrocarbons, sol. in liquid NH_3 ; At. No. 37; At. Wt. 85.44; Mol. Wt. unknown; sp. gr. 1.53; val. 1; M. P. 38.5° ; B. P. 700° ; 2 isotopes.

RbBr, *rubidium bromide*, *rubidium monobromide*. White, lustrous, octahedra or cubes; sol. in water, 89 g. in 100 g. of water at 0° , 104 g. at 16° , 152 g. at 57° ; forms many double chlorides; M. P. 682° ; sp. gr. 3.3.

RbBr₃, *rubidium bromide*, *rubidium tribromide*. Very sol. in water; decomp. by alcohol and ether; decomp. at 140° when heated.

Rb₂CO₃, *rubidium carbonate*, *normal rubidium carbonate*. White powder or cryst.; strongly alkaline; very deliq.; sol. in water and alcohol.

RbHCO₃, *rubidium carbonate*, *acid rubidium carbonate*, *rubidium hydrogen carbonate*. Glassy, prismatic cryst.; faintly alkaline; cooling taste; changed to Rb_2CO_3 by heat; easily sol. in water; M. P. 837° .

RbCl, *rubidium chloride*. White, lustrous, cubical cryst.; when heated it decrepitates, melts and volatilizes; sol. in water, 77 g. in 100 g. of water at 0° , 91 g. at 20° , 138 g. at 100° ; forms many double chlorides; M. P. 715° ; sp. gr. 2.7.

RbOH, *rubidium hydroxide*, *rubidium hydrate*. White, brittle solid with sl. grayish tinge; deliq.; strongly alkaline and caustic, more so than KOH; easily sol. in water with production of much heat, 63 g. in 100 g. of water at 30° ; not decomp. by heat, but volatilizes; sol. in alcohol; M. P. 300° ; sp. gr. 3.2.

RbNO₃, *rubidium nitrate*. Long needles or hexagonal prisms; sol. in water, 19 g. in 100 g. of water at 0° , 53 g. at 20° , 452 g. at 100° ; sol. in concd. HNO_3 (KNO_3 is not); sol. in acetone; M. P. 310° ; sp. gr. 3.1.

Rb₂O, *rubidium oxide*, *rubidium monoxide*. Yellow, transparent cryst.; reacts vigorously with water; M. P. 250° ; decomp. at 400° ; sp. gr. 3.7.

Rb₂O₂, *rubidium oxide*, *rubidium dioxide*, *rubidium peroxide*. Light yellow. cryst. masses; decomp. by water; sp. gr. 3.6.

Rb₂O₃, *rubidium oxide*, *rubidium trioxide*. Black masses; sp. gr. 3.5.

Rb₂O₄, *rubidium oxide*, *rubidium tetroxide*. Yellowish brown cryst. masses; M. P. 280° ; sp. gr. 3.

Rb₂SO₄, *rubidium sulfate*. Transparent, hexagonal cryst.; stable in air; sol. in water, 36 g. in 100 g. of water at 0° , 48 g. at 20° , 81 g. at 100° ; forms double sulfates; M. P. 1060° ; sp. gr. 3.6.

RbHSO₄, *rubidium sulfate*, *rubidium acid sulfate*, *rubidium hydrogen sulfate*. Rhombic prisms; sol. in water; sp. gr. 2.9.

Rb₂S, *rubidium sulfide*, *rubidium monosulfide*. Deliq.; very sol. in water; sp. gr. 2.9.

Rb₂S₂, *rubidium sulfide*, *rubidium disulfide*. Sol. in water.

Rb₂S₃, *rubidium sulfide*, *rubidium trisulfide*. Sol. in water; M. P. 213° .

Rb₂S₄, *rubidium sulfide*, *rubidium tetrasulfide*. Sol. in water.

Rb₂S₅, *rubidium sulfide*, *rubidium pentasulfide*. Deliq.; decomp. by water; sol. in alcohol; insol. in ether; M. P. 225° ; sp. gr. 2.6.

Ru, *ruthenium*. White, hard, heavy, brittle, lustrous metal; sometimes white, spongy masses or grayish fragments; next to Os the most infusible metal; combines with F_2 and Cl_2 at red heat; sol. in $NaOCl$, forming RuO_4 ; sol. in fused K_2CO_3 and KNO_3 , or KOH and KNO_3 , forming K ruthenate, K_2RuO_4 ; like Pt it absorbs gases when heated and "spits" them when cooling; the gray powdered form is a good catalytic agent; *colloidal Ru* and *Ru sponge* are known; besides the regular salts it forms salts analogous to the manganates and permanganates, combines with O_2 when heated in air; insol. in acids, except aqua regia, which dissolves it only very sl.; At. No. 44; At. Wt. 101.7; Mol. Wt. unknown; val. 2, 3, 4, 6, 7 and 8; sp. gr. 12.2; M. P. above 2450° ; B. P. $> 2700^{\circ}$.

RuBr₃, *ruthenium bromide*, *ruthenium tribromide*. Sol. in water, but soln. decomp., slowly on standing, rapidly on heating.

Ruthenium carbonate is of doubtful existence.

RuCl₃, *ruthenium chloride*, *ruthenium dichloride*, *ruthenous chloride*, *ruthenoso chloride*. Black cryst. masses; insol. in water, alkali soln., and acids, including aqua regia.

Ruthenium

NON-METALS AND RARE METALS

Ruthenium Cont.

RuCl_3 , *ruthenium chloride, ruthenium trichloride, rutheno-ruthenic chloride, ruthenium sesquichloride*. Brown, cryst. solid; very hygroscopic; sol. in water to an orange yellow soln. which decomp. on heating to a black insol. oxychloride or to Ru_2O_3 ; sol. in alcohol to a purple-violet soln.; decomp. in moist air; insol. in ether and CS_2 ; with alkaline chlorides it forms double salts called *rutheniochlorides* or *chlororuthenites*.

RuCl_4 , *ruthenium chloride, ruthenium tetrachloride, ruthenic chloride*. Not obtained pure; sol. in water and alcohol; with alkaline chlorides it forms double salts called *ruthenichlorides* or *chlororuthenates*.

$\text{Ru}(\text{OH})_3$, *ruthenium hydroxide, ruthenium trihydroxide, ruthenium hydrate*. Blackish brown ppt.; sol. in acids to yellow solns.; insol. in water and alkalies.

$\text{Ru}(\text{OH})_4$, *ruthenium hydroxide, ruthenium tetrahydroxide, ruthenium hydrate*. Dark red ppt.; dries to a reddish brown mass which gives off water at 300° and deflagrates at higher temp. with incandescence and black smoke; insol. in water; sol. in acids to yellow solns.; sol. in alkalies.

Ruthenium nitrate is of doubtful existence.

RuO , *ruthenium oxide, ruthenium monoxide, ruthenous oxide*. Dark gray, metal-like solid or powder; insol. in acids.

RuO_2 , *ruthenium oxide, ruthenium dioxide, ruthenic oxide*. Indigo-blue or dark violet powder or quadratic or very hard cryst. with green metallic luster and greenish or bluish iridescence; insol. in acids; sp. gr. 7.2; decomp. by heat.

Ru_2O_3 , *ruthenium oxide, rutheno-ruthenic oxide, ruthenium sesquioxide*. Blue-black powder; insol. in acids.

RuO_4 , *ruthenium oxide, ruthenium tetroxide*. Golden yellow, lustrous, rhombic prisms, that melt at 25° to 50° to an orange red liquid, which solidifies slowly to a vitreous solid; decomp. at 106° without boiling; difficultly sol. in water to a golden yellow soln. that decomp. on standing; vapor is yellow and irritating, poisonous and explosive; the most interesting compound of Ru; powerful oxidizing agent; M. P. 25.5° ; sp. gr. 5.7.

RuO_3 , *ruthenium oxide, ruthenium trioxide*, and H_2RuO_4 , *ruthenic acid* are unknown, but salts *ruthenates* and corresponding to manganates are known.

RuO_7 , *ruthenium oxide, ruthenium heptoxide*, and HRuO_4 , *diruthenic acid* or *perruthenic acid* are unknown, but salts called *diruthenates* or *perruthenates* and corresponding to permanganates are known.

Ru_2O_5 and Ru_2O_6 are said to exist but may be only mixtures.

$\text{Ru}(\text{SO}_4)_2$, *ruthenium sulfate, ruthenic sulfate*. Yellow brown, amorph. masses or a deliq., yellow powder resembling mosaic gold; deliq.; easily sol. in water.

Ru_2S_3 , *ruthenium sulfide, ruthenium sesquisulfide*. Grayish black, metal-like ppt.; insol. in water; sp. gr. 6.9.

RuS_2 and RuS_3 are said to exist.

Samarium

Sa , formerly Sm , *samarium*. Whitish gray metal; tarnishes in air; salts are topaz yellow in color; At. No. 62; At. Wt. 150.43; M. P. 1300° ; sp. gr. 7.7; val. 3.

$\text{SaBr}_3 \cdot 6\text{H}_2\text{O}$, *samarium bromide*. White cryst. powder; very. deliq.; sol. in water; sp. gr. 2.9.

$\text{Sa}_2(\text{CO}_3)_3 \cdot 3\text{H}_2\text{O}$, *samarium carbonate*. Yellow, needle cryst.; insol. in water; loses $2\text{H}_2\text{O}$ at 100° .

SaCl_2 , *samarium chloride, samarium subchloride, samarous chloride*. Reddish brown cryst. masses; sol. in water to a red brown soln. which decomp.; insol. in CS_2 , and abs. alcohol; sp. gr. 3.7.

SaCl_3 , *samarium chloride, samaric chloride*. Almost white when anhydrous; cryst. with $6\text{H}_2\text{O}$ as large, yellow, deliq. tablets; easily sol. in water; sol. in alcohol; M. P. 686° ; sp. gr. 4.4.

$\text{Sa}(\text{OH})_3$, *samarium hydroxide, samarium trihydroxide, samaric hydroxide, samarium hydrate*. Easily sol. in acids; insol. in alcohol.

$\text{Sa}(\text{NO}_3)_3 \cdot 6\text{H}_2\text{O}$, *samarium nitrate*. Easily sol. in water; very hygroscopic; sp. gr. 2.4.

Sa_2O_3 , *samarium oxide, samarium sesquioxide, samaria*. Pale yellow, amorph. powder; insol. in water; easily sol. in acids; sp. gr. 7.4.

Sa_2O_5 , *samarium oxide, samarium peroxide*. Ppt.; insol. in water.

$\text{Sa}_2(\text{SO}_4)_3 \cdot 8\text{H}_2\text{O}$, *samarium sulfate, normal samarium sulfate*. Difficultly sol. in water; forms double sulfates with alkaline sulfates; the anhydrous salt is pale yellow.

$\text{Sa}(\text{HSO}_4)_3$, *samarium sulfate, samarium acid sulfate, samarium hydrogen sulfate*. Ppt.; sl. sol. in water.

Sa_2S_3 , *samarium sulfide, samarium sesquisulfide*. Known.

Scandium

Sc, *scandium*. Usually associated with the rare earth metals; apparently has not been isolated yet; salts are colorless and hydrolyze in aq. soln.; At. No. 21; At. Wt. 45.10; M. P. 1200°; B. P. 2400°; sp. gr. 2.5(?); 1 isotope; val. 3.

ScBr₃, *scandium bromide, scandium tribromide*. Cryst. with 6H₂O; sol. in water; sp. gr. 3.9.

Sc₂(CO₃)₃, *scandium carbonate*. Voluminous, white ppt.; cryst. with 12H₂O when it dries; insol. in water; sol. in acids; decomp. a little when heated.

ScCl₃, *scandium chloride, scandium trichloride*. White solid; deliq.; sol. in water with a hissing sound and then hydrolyzes; insol. in alcohol; M. P. 930°.

Sc(OH)₃, *scandium hydroxide, scandium trihydroxide, scandium hydrate*. White, voluminous, gelatinous ppt.; dries to hard mass; decomp. to Sc₂O₃ by heat; insol. in water and solns. of alkaline hydroxides; easily sol. in dil. and concd. HNO₃ or HCl.

Sc(NO₃)₃·4H₂O, *scandium nitrate*. Prismatic colorless cryst.; forms a basic nitrate when heated; very deliq.; M. P. 150°; sol. in water and alcohol.

Sc₂O₃, *scandium oxide, scandium sesquioxide, scandia*. White powder; very light; resembles MgO; easily sol. in hot, concd. HNO₃, HCl, or H₂SO₄; sp. gr. 3.8.

Sc₂(SO₄)₃, *scandium sulfate*. Easily sol. in water; sol. in alcohol; sp. gr. 2.6.

Sc₂S₃, *scandium sulfide, scandium sesquisulfide*. Yellow solid; stable in air; decomp. by water and acids, evolving H₂S.

Selenium

Se, *selenium*. Several modifications exist, passing from one to another with change in temp.; *amorph. Se* is a dark red to black powder, of sp. gr. 4.5 and sol. in CS₂, or black, vitreous, lustrous solid, appearing red in thin layers, of sp. gr. 4.3, sol. in CS₂, with no fixed M. P., softening at 60° and becoming totally liquid at 220°; *cryst. Se* forms small, black, microscopic, glittering leaflets, of sp. gr. 4.8, and insol. in CS₂, or small, red, thin, transparent, lustrous cryst. black and opaque in thick layers, of sp. gr. 4.5, M. P. 220°, insol. in CS₂, and turning black when heated; *gray Se* is a gray, lustrous, metal-like, granular solid, resembling pig iron, of sp. gr. 4.4, M. P. 217°, and insol. in CS₂; Se resembles S and Te; may be distilled in vacuum or an indifferent gas; burns with a blue flame to SeO₂ when heated in air, giving a strong rotten radish odor; boils at c. 680° to dark yellow vapor; *colloidal Se* is a dark red powder, completely sol. in water forming a red fluorescent soln.; Se may be changed from one form to the other easily by means of heat or proper solvents; boils to a dark red vapor which condenses as scarlet flowers of selenium; metallic Se conducts electricity, and light increases the conductivity, but *amorph. Se* is a poor conductor; insol. in water; sol. in concd. H₂SO₄, evolving SO₂ and forming Se acids; sol. in fuming H₂SO₄; hot, concd. HNO₃ forms H₂SeO₃ and NO; insol. in HCl; sol. in alkali solns., forming selenides; At. No. 34; At. Wt. 79.2; Mol. Wt. 158.4; sp. gr. varies with the variety; val. 2, 4 and 6; M. P. generally 220°; B. P. 688°.

Se₂Br₃, *selenium bromide, selenium monobromide, selenious bromide*. Thin, oily liquid; dark reddish brown in color, but black in quantity; unpleasant odor resembling that of S₂Cl₂; decomp. by heat; sinks in water and then decomp.; sol. in CS₂; changed to SeBr₄ by alcohol; colors skin permanently red brown; sp. gr. 3.6.

SeBr₄, *selenium bromide, selenium tetrabromide, selenic bromide*. Black, lustrous, hexagonal leaflets when impure, dark orange when pure; disagreeable odor resembling that of S₂Cl₂; volatile; sol. in CS₂; sol. with decomp. in water, alcohol, or dil. HCl; decomp. in moist air.

Selenium carbonate is unknown.

SeCl₂, *selenium chloride, selenium monochloride, selenious chloride*. Heavy, deep red liquid; odor resembles that of S₂Cl₂; volatile to an orange colored vapor; sl. decomp. by water, alcohol or ether; sol. in CS₂; insol. in concd. H₂SO₄; easily sol. in fuming H₂SO₄; sp. gr. 2.9.

SeCl₄, *selenium chloride, selenium tetrachloride, selenic chloride*. Pale yellow, cryst. solid; volatilizes without melting when heated to a yellow vapor; nearly insol. in CS₂; deliq. in moist air; decomp. by water.

Selenium hydroxide is unknown, unless the hypothetical hydrated Se acids might be considered as hydroxides.

Selenium nitrate is unknown.

SeO₃, *selenium oxide, selenium dioxide, selenious oxide, selenious anhydride, selenious acid anhydride*. Long, white, lustrous, four-sided needles, or dense, cryst. masses; deliq.; vaporizes to a greenish yellow vapor with strongly acid odor; M. P. 340°; sp. gr. 3.9; easily sol. in water, forming H₂SeO₃; easily sol. in alcohol; sol. in glacial HC₂H₃O₂.

Selenium
Cont.

SeO₃, *selenium oxide, selenium trioxide, selenic acid anhydride, selenic anhydride*. Not known in free state, only in combination with water as H₂SeO₄.

Selenium sulfate is unknown.

SeS, *selenium sulfide, selenium monosulfide*. Of doubtful existence; said to be small, orange yellow, lustrous tablets; melts and decomp. when heated; sol. in CS₂; insol. in ether and water; decomp. by alcohol.

Silicon

Si, *silicon*. Exists in two forms, amorph. and cryst.; *amorph. Si* is a lustrous, brown powder; adheres readily to glass; heavier than concd. H₂SO₄; burns when heated in air or O₂, but the SiO₂ formed soon stops further oxidation; insol. in water; sol. before ignition in cold HF, forming SiF₄ and H₂; insol. in other mineral acids and aqua regia; sol. in concd. KOH + Aq; after ignition Si is insol. in HF and KOH + Aq; *cryst. Si* occurs as needles or opaque, very lustrous, metal-like, grayish black leaflets resembling graphite; both *cryst. forms* consist of regular octahedra; hard enough to scratch glass; is not changed when heated, even to whiteness, in O₂; insol. in all acids, except a mixture of HF and HNO₃; sol. in KOH + Aq; *amorph. Si* dissolves in many melted metals, forming *silicides* with some metals, while in others it simply dissolves and separates again on cooling; *amorph. Si* is a non-conductor of electricity, while the *cryst. does conduct*; combines with Cl₂ when hot, with F₂ when cold; insol. in liquid NH₃; At. No. 14; At. Wt. 28.06; Mol. Wt. unknown; sp. gr. 2.4; val. 4; M. P. 1420°; B. P. 2600°; 3 isotopes.

Si₂Br₆, *silicon bromide, silicon tribromide, disilicon hexabromide*. Large, colorless *cryst. tablets* or colorless liquid; melts at 95°; distills at 240° without decomp.; decomp. by KOH + Aq.

SiBr₄, *silicon bromide, silicon tetrabromide*. Colorless liquid; disagreeable odor; fumes strongly in air; solidifies at -12°; decomp. by water and concd. H₂SO₄; M. P. 5°; B. P. 153°; sp. gr. 2.8.

Si₂Br₅ and **Si₂Br₁₀** are said to exist.

Silicon carbonate is unknown.

SiCl₃ or **Si₂Cl₆**, *silicon chloride, silicon trichloride, disilicon hexachloride*. Colorless, mobile liquid; fumes in air; decomp. by water and alkalis; solidifies at -14° to large leaflets; vapor is spontaneously flammable in air; M. P. -1°; B. P. 146°; sp. gr. 1.6.

SiCl₄, *silicon chloride, silicon tetrachloride*. Colorless liquid; very clear and mobile; disagreeable odor, resembling cyanides; fumes in moist air; decomp. by water and alcohol; M. P. -70°; B. P. 59°.

SiCl₃, *silicon chloride, silicon dichloride*. Of doubtful existence; said to be spontaneously flammable and decomp. by water.

Si₂Cl₅, *silicon chloride, silicon octachloride*. Colorless liquid;; decomp. by cold water; M. P. -67°; B. P. 210°.

Other *silicon chlorides* are said to exist.

Si(OH)₄, *silicon hydroxide*. Not known as *silicon hydroxide*, but as *silicic acid*; see *silicic acid* under **Acids**.

Silicon nitrate is unknown.

SiO, *silicon oxide, silicon monoxide*. Similar to SiO₂; much less easily sol. in dil. HF than is SiO₂; more easily sol. in solns. of alkalis.

SiO₂, *silicon oxide, silicon dioxide, silicic acid anhydride, silicic anhydride, silica, sand, quartz*; also as the main constituent of sandstones and many other minerals, *agate, flint, freestone, glass sand, hyalite, chalcedony, grind stone, infusorial earth, rotten stone, cristobalite, millstone, sandstone, lechatelierite, opal, siler, opalized wood, randanite, silicified wood, rock crystal, smoky quartz, rose quartz, tripoli, and tridymite*; occurs in two forms, *amorph. and cryst.*; *amorph. SiO₂* is a loose, white, tasteless powder; sp. gr. 2.2; insol. in water and acids, except HF; sol. in hot, alkali solns., but less sol. if SiO₂ has been ignited; *cryst. SiO₂* occurs as colorless, transparent, hexagonal prisms; sp. gr. 2.6; insol. in water and acids except HF; insol. or nearly so in hot KOH + Aq; SiO₂ may be fused in the oxy-hydrogen flame to a colorless glass that may be drawn into fine threads, or shaped into apparatus; the colors of the different varieties of native silica are due largely to impurities.

Silicon sulfate is unknown.

SiS, *silicon sulfide, silicon monosulfide*. Yellow solid; decomp. by water, evolving H₂S; decomp. by dil. KOH + Aq, evolving H₂; sp. gr. 1.8.

SiS₂, *silicon sulfide, silicon disulfide*. Long, white, lustrous, silky needles; volatile at high temp.; stable in dry air; decomp. in moist air; burns to SiO₂ and SO, when heated in air; decomp. by cold alcohol and ether.

S, sulfur, brimstone. Occurs in several modifications,—rhombic, prismatic, amorph., rubbery, and colloidal. *Rhombic S* is a pale yellow, tasteless, very brittle solid, or rhombic (octahedral) cryst. that show many modifications of the type cryst.; highly lustrous; becomes darker yellow by heating, paler yellow by cooling; melts to a clear yellow liquid at 112.8° ; at c. 150° the liquid begins to darken and thicken; between 170° and 200° it is black, and so viscous as not to run; at 330° to 340° the liquid becomes thin, but remains dark colored till it boils at 444.6° ; burns in air with a blue flame to SO_2 ; vaporizes easily above its M. P. if air is excluded to a yellow vapor, called *flowers of sulfur*, *flowers of brimstone*, *sulfur flowers*, *sulfur flour*; sp. gr. 2.07; insol. in water; sol. in alcohol and CS_2 . *Prismatic S* forms long, slender, transparent, yellow or yellowish brown needles that change gradually and crumble to rhombic cryst.; sp. gr. 1.96; insol. in water, sol. in CS_2 . *Amorph. S* forms yellow, lustrous, brittle, amorph. masses; sp. gr. 2.07; insol. in water; sol. in CS_2 . *Rubbery S* or *plastic sulfur* occurs as soft, yellow, brown or black, gummy strings or lumps that change to yellow amorph. S on standing in air; sp. gr. 1.9. *Colloidal S* is said to exist as a soln. of S in water. *Precipitated S*, *lac sulfur*, *magister of sulfur*, is an extremely finely divided form of S, very pale yellow in color. At. No. 16; At. Wt. of S is 32.065; Mol. Wt. 64.13; probably also 192.39 and 256.52; val. 2, 4 and 6; 1 isotope; a saturated CS_2 soln. of S deposits rhombic S, but solns. of S in alcohol, ether or chloroform deposit monoclinic or prismatic S; pptd. S suspended in water is called *milk of sulfur*; S may be changed from one form to another by means of heat, sunlight or the proper solvents; ignites at c. 280° in O_2 and at c. 360° in air; the flame in O_2 is bluer than in air; the product is chiefly SO_2 , but increased pressure increases the amount of SO_3 formed; the yellow color of S is deeper at 100° and almost disappears at -50° ; several classifications of the different modifications of S have been devised; not all these modifications are true allotropic forms however; S is sol. in other solvents besides CS_2 , but the solubility varies with the modification and the conditions; combines with most metals and non-metals, forming sulfides; combines directly with H and the halogens.

SBr or S_2Br_2 , sulfur bromide, sulfur monobromide. Deep, garnet-red or ruby-red liquid; volatilizes; decomp. by moisture; decomp. by water, slowly cold, rapidly hot; dissolves S; M. P. -46° ; B. P. 190° , but only 57° under reduced pressure; sp. gr. 2.6.

Sulfur carbonate is unknown.

S_2Cl_2 , sulfur chloride, sulfur monochloride, sulfur protochloride. Deep yellow, or yellowish red, oily liquid; acid taste; very characteristic, penetrating, disagreeable odor; most stable of the S chlorides; vaporizes easily to a lacrymatory vapor; fumes in air; sol. in CS_2 ; sol. in alcohol and ether with decomp.; decomp. by water; dissolves S; M. P. -80° ; B. P. 138° ; sp. gr. 1.7.

SCl_2 , sulfur chloride, sulfur dichloride. Thin, dark, brownish red liquid; resembles S_2Cl_2 in taste and odor; decomp. slowly in sunlight, by water, or by heat, immediately by alcohol or ether; still liquid at -30° ; M. P. -78° ; B. P. 64° ; sp. gr. 1.6.

SCl_4 , sulfur chloride, sulfur tetrachloride. Mobile, yellowish brown liquid at or below -20° ; boils, evolves Cl_2 , and decomp. above -20° ; decomp. by water; forms a yellowish white solid at -30° ; M. P. -30° .

$\text{S}(\text{OH})_4$ or $\text{S}(\text{OH})_6$, sulfur hydroxide. Not known as *sulfur hydroxide*; possibly the hydrated S acids might be considered as the hydroxides.

Sulfur nitrate is unknown.

SO_2 , sulfur oxide, sulfur dioxide, sulfurous oxide, sulfurous anhydride, sulfurous acid anhydride. Colorless gas, with strong, characteristic, suffocating odor; does not burn nor support combustion; extinguishes flame; when mixed with O_2 and passed over hot Pt sponge it is changed to SO_3 ; does not redden blue litmus when dry; with water forms sulfurous acid, a weak unstable acid; SO_2 bleaches many vegetable colors, but the colors are generally restored by alkalis; may be condensed at c. -10° and ordinary pressure to a colorless, mobile liquid that evaporates rapidly when exposed to air, sometimes forming at the same time a white, woolly mass of solid SO_3 ; sp. gr. of gas 2.3, of liquid 1.5; one volume of water dissolves 79 volumes of SO_2 at 0° , 60 volumes at 5° , 39 volumes at 20° , and 18 volumes at 40° ; critical temp. is 257° ; critical pressure is 77.9 atmospheres; sol. in alcohol; powerful antiseptic; an anti-putrefaction agent; gaseous SO_2 is decomp. by sunlight to S and SO_3 ; it absorbs much heat when evaporating; M. P. -72.7° ; B. P. c. -10° .

SO_3 , sulfur oxide, sulfur trioxide, sulfuric oxide, sulfuric anhydride, sulfuric acid anhydride. Colorless, mobile liquid, solidifying at c. 15° to long, prismatic, transparent cryst. which melt at c. 15° ; very acid; chars organic matter; very

NON-METALS AND RARE METALS

Sulfur Cont.

hygroscopic; sol. in water with hissing sound, production of much heat, and formation of H_2SO_4 ; does not redden blue litmus when dry; B. P. c. 46° ; absorbs moisture rapidly from air evolving dense white fumes of H_2SO_4 ; M. P. 16.8° ; sp. gr. 1.92.

S_2O and S_2O_2 are also said to exist.

S_2O_3 , *sulfur oxide, sulfur sesquioxide*. Blue mass, first liquid, then solid; decomp. to S and SO_2 ; decomp. violently by water; sol. in fuming H_2SO_4 to a blue soln.

Sulfur sulfate is probably not known; the formula, SSO_4 , for *sulfur sulfate* seems to resolve itself into 2SO_2 .

Sulfur sulfide is unknown unless dimolecular sulfur, S_2 , might be considered as *sulfur sulfide*.

Tantalum

Ta, *tantalum*. Impure Ta is a black powder with metallic luster; burns when heated in air; pure Ta is silver white; resembles Pt; malleable and ductile; hard as steel; very high tensile strength; absorbs H_2 when heated; attacked by fused alkalis, but not by their solns.; combines with Cl_2 , N_2 and S when hot; alloys with a few metals; superficially oxidized when heated; red hot powdered Ta decomp. water; compounds are similar to those of Cb; val. 2, 3, 4 and 5; sol. in HF; insol. in other acids; At. No. 73; At. Wt. 181.5; Mol. Wt. unknown; sp. gr. 16.6; M. P. 2850° ; B. P. 4100° .

TaBr_5 , *tantalum bromide, tantalum pentabromide*. Yellow cryst. solid; resembles TaCl_5 ; decomp. by water; M. P. 240° .

Tantalum carbonate is unknown.

$\text{TaCl}_5 \cdot 2\text{H}_2\text{O}$, *tantalum chloride, tantalum dichloride*. Green, hexagonal cryst., or blackish green mass; unstable in air; insol. in water.

TaCl_3 , *tantalum chloride, tantalum trichloride*. Green; sol. in water to a green soln.

TaCl_5 , *tantalum chloride, tantalum pentachloride*. Pale yellow, or white, prismatic cryst.; deliq.; begins to volatilize at 144° ; decomp. in air and completely in water; sl. sol. in $\text{KOH} + \text{Aq}$; concd. H_2SO_4 and HCl decomp. it, pptg. a hydrated oxide; fumes in moist air, forming tantalic acid; M. P. 221° ; B. P. 242° ; sp. gr. 3.7.

$\text{Ta}(\text{OH})_5$, *tantalum hydroxide*, better known as H_2TaO_5 , *tantallic acid*. Compn. varies; gelatinous ppt. or cryst.; insol. in water; sol. in acids when fresh; sol. in solns. of caustic hydroxides; decomp. to Ta_2O_5 with incandescence when heated; forms salts called *tantalates*.

Tantalum nitrate is of doubtful existence.

Ta_2O_5 , *tantalum oxide, tantalum tetroxide*, or TaO_3 , *tantalum dioxide*. Brown powder; burns to Ta_2O_5 when heated; insol. in all acids.

Ta_2O_5 , *tantalum oxide, tantalum pentoxide*. White powder or prismatic cryst.; infusible; insol. in all acids.

$\text{Ta}_2(\text{SO}_4)_5$, *tantalum sulfate*. Compn. is indefinite.

Ta_2S_5 , or TaS_5 , *tantalum sulfide, tantalum tetrasulfide*. Gray mass resembling graphite, or yellowish black solid resembling SO_2 ; changed to Ta_2O_5 by heat; insol. in HCl ; oxidized to H_2TaO_5 by HNO_3 or aqua regia.

Tellurium

Te, *tellurium*. White, lustrous, very brittle, cryst. solid, or hexagonal, rhombohedral cryst.; stable in air; amorph. Te is a brown powder that changes to the cryst. variety when heated; forms a golden yellow vapor; when heated in air it burns with a brilliant, blue-green flame to white TeO_2 , sometimes accompanied by the rotten radish odor of Se compounds; sublimes at high temp.; insol. in water and HCl ; sl. sol. in hot, concd. H_2SO_4 , but separates out on cooling; more sol. in boiling, concd. H_2SO_4 , with evolution of SO_2 ; easily oxidized by HNO_3 or aqua regia to H_2TeO_5 ; sol. in concd. boiling $\text{KOH} + \text{Aq}$ to a red liquid, but separates out on cooling; insol. in CS_2 ; sol. in cold, fuming H_2SO_4 to a deep red soln. from which Te is pptd. on dilution with water; unites directly with Br and Cl; insol. in liquid NH_3 ; good conductor of heat and electricity; colloidal Te is known; At. No. 52; At. Wt. 127.5; Mol. Wt. probably 255; val. 2, 4 and 6; sp. gr. 6.24; M. P. 452° ; B. P. c. 1390° ; 3 isotopes.

TeBr_2 , *tellurium bromide, tellurium dibromide, tellurous bromide*. Blackish green, cryst. mass, or steel gray to black needles; vapor is violet; very hygroscopic; decomp. by water to H_2TeO_5 and HBr ; M. P. 280° ; B. P. c. 340° .

TeBr_4 , *tellurium bromide, tellurium tetrabromide, telluric bromide*. Cryst. crusts; orange colored when cold, fiery red when hot; sol. in a little water to a yellow soln. with decomp. by much water to a colorless soln. of H_2TeO_5 and HBr ; M. P. 380° ; B. P. 414° to 460° ; sp. gr. 4.3.

Tellurium
Cont.

Tellurium carbonate is of doubtful existence.

TeCl₂, *tellurium chloride, tellurium dichloride, tellurous chloride*. Black, amorph. solid or cryst.; greenish yellow when powdered; melts at 175° to a black liquid; boils at 327° or 377°; the vapor is reddish or yellowish; much water forms H₂TeO₃; sp. gr. 6.9.

TeCl₄, *tellurium chloride, tellurium tetrachloride, telluric chloride*. Colorless or white, cryst., solid; very deliq.; insol. in CS₂; M. P. 214°; boils at 380° without decomp.; decomp. by cold water to H₂TeO₃ and oxychloride; with alkaline chlorides it forms double salts called *chlorotellurates*.

Te(OH)₆, or **Te(OH)₄**, *tellurium hydroxide*. Not known as *tellurium hydroxide* but as the hydrated Te acids, H₂TeO₃, *tellurous acid* or *telluric acid*, and H₂TeO₄, *telluric acid*; these acids form salts called respectively *tellurites* and *tellurates*.

TeNO₃, *tellurium nitrate*. Sol. in acetone.

Te(NO₃)₄, *tellurium nitrate*. Of indefinite compn.; rhombic cryst.; very hygroscopic; decomp. by water; sol. in dil. HNO₃.

TeO, *tellurium oxide, tellurium monoxide*. Brownish black, amorph. solid; has graphite-like luster when pressed with a hard body; stable in air; burns to TeO₂ when heated; sl. sol. in cold, dil. HCl or H₂SO₄; easily oxidized by HNO₃ or aqua regia; only slowly decomp. by KOH + Aq.

TeO₂, *tellurium oxide, tellurium dioxide, tellurous oxide, tellurous anhydride, tellurous acid anhydride, telluric oxide*. White, cryst. solid, or quadratic octahedra, or rhombic needles; melts at red heat to a transparent, yellow liquid, which cools to a white, cryst. mass that glows feebly; metal-like taste; does not redden litmus; very sl. sol. in water; sl. sol. in most acids, most in HCl; easily sol. in NaOH + Aq or KOH + Aq; sp. gr. 5.6.

TeO₃, *tellurium oxide, tellurium trioxide, telluric oxide, telluric anhydride, telluric acid anhydride*. Orange-yellow cryst. or cryst. mass; decomp. to TeO₂ and O₂ when heated; insol. in hot or cold water, cold HCl and hot or cold HNO₃; insol. in dil., sol. in boiling concd. KOH + Aq; sp. gr. 5.1.

Te(SO₄)₂, *tellurium sulfate*. Cryst. mass; decomp. by hot water; sol. in dil. H₂SO₄.

TeS, *tellurium sulfide, tellurium monosulfide*. Very unstable; insol. in CS₂.

TeS₂, *tellurium sulfide, tellurium disulfide*. Dark brown ppt.; fuses to gray lustrous mass; insol. in water and dil. acids; sol. in alkaline sulfide and hydroxide solns.; CS₂ dissolves out the S.

TeS₃, *tellurium sulfide, tellurium trisulfide*. Blackish gray, lustrous solid; insol. in water.

Tb, *terbium*. The metal has not been isolated; solns. of its salts are colorless; val. 3; At. No. 65; At. Wt. 159.2.

Terbium

TbBr₃, *terbium bromide*. Known.

Tb₂(CO₃)₃, *terbium carbonate*. Ppt.; insol. in water and (NH₄)₂CO₃ + Aq.

TbCl₃, *terbium chloride*. Colorless cryst.; melts to a colorless liquid; very hygroscopic; sol. in water and alcohol; M. P. 588°; sp. gr. 4.3; cryst. with 6H₂O to deliq. prisms.

Tb(OH)₃, *terbium hydroxide, terbium trihydroxide, terbium hydrate*. White, gelatinous ppt.; insol. in water; sol. in dil. acids; absorbs CO₂ from the air.

Tb(NO₃)₃·6H₂O, *terbium nitrate*. Monoclinic needle cryst.; sol. in water and alcohol; M. P. 89°.

Tb₂O₃, *terbium oxide, terbium sesquioxide, terbia*. White, amorph. powder; sol. in dil. acids, even after ignition.

Tb₂O₄, *terbium oxide, terbium heptoxide, terbium peroxide*. Dark brown or black powder; sol. in HNO₃ and hot HCl.

Tb₂(SO₄)₃·8H₂O, *terbium sulfate*. Sol. in water; insol. in alcohol.

Tb₂S₃, *terbium sulfide*. Known.

Tl, *thallium*. White metal; very soft; can be scratched by Pb; less tenacious than Pb; can be squeezed, but not drawn, into wire; very inelastic; takes high polish when rubbed under water; cryst. easily in octahedra; crackles like Sn when bent; tarnishes quickly in air with coating of oxide that protects the rest of the metal; melts easily at c. 290° without becoming pasty; boils at white heat; volatilizes at red heat; burns easily in air to Tl₂O; vapor is pale red and has a peculiar odor; amalgamates with Hg and forms alloys with many other metals; slowly sol. in alcohol; insol. in liquid NH₃; combines directly with S, P, and the halogens; like Pb, Tl compounds are cumulative poisons; forms 2 series of compounds, thallos and thallic, the former being the more stable; insol. in

Thallium

Thallium
Cont.

water; easily sol. in dil. H_2SO_4 or HNO_3 ; difficultly sol. in HCl ; At. No. 81; At. Wt. 204.4; Mol. Wt. probably the same; val. 1 and 3; sp. gr. 11.85; M. P. 303.5° ; B. P. 1650° .

TlBr , *thallium bromide, thallium monobromide, thallos bromide*. White ppt.; almost insol. in water; melts at 460° to a brownish yellow liquid which solidifies to a yellow solid; insol. in acetone; sp. gr. 7.5.

TlBr_2 , *thallium bromide, thallium dibromide*. Long, yellow needles.

TlBr_3 , *thallium bromide, thallium tribromide, thallic bromide*. Yellow, cryst. solid; very deliq., becoming brown and evolving Br_2 ; very sol. in water; sol. in alcohol.

TlBr_3 , *thallium bromide, thallium sesquibromide, thallo-thallic bromide*. Orange red, hexagonal leaflets; decomp. by water.

Tl_2CO_3 , *thallium carbonate, thallos carbonate*. Heavy, colorless, shiny, highly refractive prisms; melts to dark gray mass; decomp. by heat; sl. alkaline to taste and test paper; sol. in water, 4 g. in 100 g. of water at 15° , 27 g. at 100° ; insol. in abs. alcohol; M. P. 272° ; sp. gr. 7.

TlCl , *thallium chloride, thallos chloride*. White, cryst. solid; resembles PbCl_2 ; turns violet on exposure to light; melts at 430° to a clear yellow liquid which solidifies white; sl. sol. in water; insol. in alcohol and NH_4OH ; sol. in hot $\text{Na}_2\text{CO}_3 + \text{Aq}$; sp. gr. 7.

TlCl_2 , *thallium chloride, thallium dichloride*. Yellow solid; fuses easily.

TlCl_3 , *thallium chloride, thallic chloride*. White cryst. solid; M. P. 24° ; cryst. with $4\text{H}_2\text{O}$ as large colorless prisms; M. P. 37° .

Tl_2Cl_4 , *thallium chloride, thallium sesquichloride, thallo-thallic chloride*. Yellow, hexagonal leaflets; stable in air; melts at 400° to 500° to a dark brown liquid; very sl. sol. in water.

Other chlorides intermediate between the thallos and thallic chlorides are known.

TlOH , *thallium hydroxide, thallium monohydroxide, thallos hydroxide, thallium hydrate*. Pale yellow, prismatic cryst.; probably hydrated; easily sol. in water to a strongly alkaline soln. that absorbs CO_2 from the air and ppts. heavy metals; sol. in alcohol.

$\text{Tl}(\text{OH})_3$, *thallium hydroxide, thallium trihydroxide, thallic hydroxide, thallium hydrate*. Of indefinite compn.; brown ppt., resembling $\text{Fe}(\text{OH})_3$; insol. in water and dil. alkaline solns.; decomp. when heated; sol. in dil. acids and NH_4 salt solns.

TlNO_3 , *thallium nitrate, thallos nitrate*. Opaque, white, rhombic prisms; sol. in water, 4 g. in 100 g. of water at 0° , 9 g. at 20° , 414 g. at 100° ; insol. in alcohol; sp. gr. 5.5; melts at 206° and solidifies to a glass-like solid; decomp. at 450° .

$\text{Tl}(\text{NO}_3)_3$, *thallium nitrate, thallic nitrate*. Large, colorless, deliq. cryst., containing $3\text{H}_2\text{O}$; decomp. at 100° ; forms double nitrates.

Tl_2O , *thallium oxide, thallium monoxide, thallos oxide*. Black powder; melts at c. 300° to a dark yellow liquid; deliq.; easily sol. in water to an alkaline soln.; sol. in abs. alcohol.

Tl_2O_3 , *thallium oxide, thallium trioxide, thallic oxide*. Brownish black or dark red powder or hexagonal leaflets; melts at c. 759° ; decomp. at high heat; insol. in water; insol. in cold, sol. in hot, H_2SO_4 ; sol. in HCl ; insol. in alkali solns.; sp. gr. 9.6.

TlO_2 , *thallium oxide, thallium dioxide*. Insol. in water.

TlSO_4 , *thallium sulfate, normal thallium sulfate, thallos sulfate*. White, rhombic prisms; volatilizes without decomp.; sol. in water, 2.7 g. in 100 g. of water at 0° , 4.8 g. at 20° , 16.5 g. at 90° ; more sol. in dil. H_2SO_4 than in water; M. P. 632° ; sp. gr. 6.7; forms alums with trivalent sulfates and double salts not alums with many other sulfates.

$\text{TiHSO}_4 \cdot 3\text{H}_2\text{O}$, *thallium sulfate, thallium acid sulfate, thallium hydrogen sulfate*. Short, thick prisms; M. P. 120° ; decomp. by heat to H_2SO_4 and the normal sulfate.

$\text{Tl}_2(\text{SO}_4)_2$, *thallium sulfate, thallic sulfate*. Thin, white leaflets; easily hydrolyzed by water forming basic salts; forms double sulfates.

Tl_2S , *thallium sulfide, thallium monosulfide, thallos sulfide*. Black, cryst., brittle solid, or very small, lustrous, blue-black cryst., or black, amorph., graphite-like powder; sp. gr. 8.0; oxidizes to sulfate in air; insol. in water and solns. of alkaline hydroxides, carbonates and sulfides; sol. in dil. H_2SO_4 and HNO_3 ; less sol. in dil. HCl ; sl. sol. in $\text{HC}_2\text{H}_3\text{O}_2$.

Tl_2S_3 , *thallium sulfide, thallium sesquisulfide, thallic sulfide*. Black, amorph. solid; melts easily; brittle below 12° , soft and viscous above 12° ; insol. in water;

insol. in cold, sol. in warm, H_2SO_4 without separation of S; sol. in other dil. acids with separation of S.

Th_2S_3 , *thallium sulfide, thallium pentasulfide*. Black ppt. or black lustrous prisms.

Thallium
Cont.

Th, thorium. Grayish white, lustrous powder consisting of small, thin, hexagonal, cryst. leaflets; the larger cryst. are white and lustrous as Ag, the smaller ones are gray and less lustrous; somewhat brittle; unchanged in air up to 120° ; at higher temp. it burns with white light to ThO_2 ; infusible; somewhat ductile and malleable; when finely powdered it ignites in air under sl. friction; is strongly radioactive; glows and forms a salt when heated in Cl_2 , Br_2 , I_2 , or S; solns. of its salts are colorless; insol. in $\text{NaOH} + \text{Aq}$ and $\text{KOH} + \text{Aq}$; val. 2 and 4; insol. in water; insol. in cold, sol. in warm, dil. H_2SO_4 ; sol. in HCl ; sl. sol. in HNO_3 ; easily oxidized by aqua regia; At. No. 90; At. Wt. 232.15; Mol. Wt. unknown; sp. gr. 11.2; M. P. 1845° ; B. P. $>3000^\circ$.

ThBr_3 , *thorium bromide, thorium dibromide*. Sol. in water with partial decomp.

ThBr_4 , *thorium bromide, thorium tetrabromide*. White, gummy masses; resembles ThCl_4 ; sol. in water and alcohol, sometimes with decomp. in the former; sp. gr. 5.7.

$\text{Th}(\text{CO}_3)_2$, *thorium carbonate*. The normal carbonate is unknown; the basic carbonate is pptd. by alkaline carbonates, in solns. of which it is sol., forming sol. double salts therewith; insol. in $\text{CO}_2 + \text{Aq}$.

ThCl_4 , *thorium chloride, thorium tetrachloride*. Colorless solid, or white, lustrous needles; deliq.; partially volatile; M. P. 820; sp. gr. 4.6; cryst. with 2, 4, 7, 8, or 9 H_2O , all of which salts are deliq. and sol. in water and alcohol; forms double chlorides with alkaline chlorides; also forms basic chlorides.

$\text{Th}(\text{OH})_4$, *thorium hydroxide, thorium hydrate*. White, gelatinous ppt. or hard, white solid; combines with CO_2 in air; insol. in water; sol. in acids except HF ; easily sol. in solns. of alkali carbonates but insol. in their hydroxide solns.

$\text{Th}(\text{NO}_3)_4$, *thorium nitrate*. Cryst. with 2, 5, 6 or 12 H_2O as large translucent, deliq. tablets; very sol. in water and alcohol; insol. in acetone; forms many double nitrates.

ThO_2 , *thorium oxide, thorium dioxide, thoria*. Fine, white, or gray to grayish yellow, powder; pure thoria is a snow white powder or tetragonal cryst. of sp. gr. 10.2; infusible; incandesces when heated; only sl. sol. in acids; insol. in alkali solns.; its properties and its solubility in acids depend on its method of preparation; sp. gr. 9.7; M. P. $>2800^\circ$.

Th_2O_3 , *thorium oxide, thorium peroxide*. Unstable, losing O and leaving ThO_2 , *thorium trioxide*.

$\text{Th}(\text{SO}_4)_2$, *thorium sulfate, normal thorium sulfate*. White, cryst. ppt. or powder: very sol. in ice water and forms highly supersaturated solns.; easily sol. in much, sl. in a little, water; cryst. with 2, 4, 6, 8, or 9 H_2O , the last forming transparent, monoclinic cryst. of sp. gr. 2.8 and decomp. when heated; forms double salts with alkali sulfates.

$\text{ThH}_4(\text{SO}_4)_2$, *thorium sulfate, thorium acid sulfate, thorium hydrogen sulfate*. Insol. in cold, sol. in hot, water.

ThS_2 , *thorium sulfide*. Large, brown cryst., or yellow, metal-like powder; spontaneously flammable in air; burns to SO_2 and ThO_2 ; reacts violently with HNO_3 , pptg. ThOS ; sp. gr. 6.8; insol. in warm H_2SO_4 ; sol. in hot aqua regia.

Tm (formerly Tu), thulium. Probably has not been isolated; its salts are green; solns. of its salts are green or bluish green; At. No. 69; At. Wt. 169.4; val. 3.

TmBr_3 , *thulium bromide*. Probably known.

$\text{Tm}_2(\text{CO}_3)_3$, *thulium carbonate*. Known.

TmCl_3 , *thulium chloride*. Cryst. with 7 H_2O as green cryst.; easily sol. in water and alcohol.

$\text{Tm}(\text{OH})_3$, *thulium hydroxide, thulium hydrate*. Known; easily sol. in dil. acids.

$\text{Tm}(\text{NO}_3)_3$, *thulium nitrate*. Cryst. with 4 H_2O as green cryst.; very sol. in water.

Tm_2O_3 , *thulium oxide, thulium sesquioxide, thulia*. Dense, white powder with greenish tinge; glows, first red, then yellow, and finally white, when heated; slowly sol. in hot, concd. acids.

$\text{Tm}_2(\text{SO}_4)_3$, *thulium sulfate*. Cryst. with 8 H_2O as green cryst.; sol. in water; insol. in alcohol.

Tm_2S_3 , *thulium sulfide*. Probably known.

Thorium

Thulium

Titanium

Ti, *titanium*. Dark gray or black, lustrous, amorph. powder; perhaps also hard, steel colored, cubic cryst.; burns with brilliant white light to TiO_2 in air or O_2 ; brittle when cold, but somewhat malleable and volatile when hot; stable in air up to 120° ; the only element which burns vigorously in N_2 , the reaction beginning at c. 800° ; when burned in air it forms both TiO_2 and Ti_3N_2 ; forms a red compound of indefinite compn. with C; burns in Cl_2 at 350° , in Br_2 and I_2 at higher temp.; combines with nearly all non-metals when heated; alloys with most metals; oxidized by HNO_3 to titanic acid; addition to steel forms steels of great tensile strength and resistant to shocks and abrasion; poor conductor of electricity; decomp. water at 100° , giving H_2 ; easily sol. in HCl if warm; sol. in cold, dil. H_2SO_4 , HNO_3 or $\text{H}_2\text{C}_2\text{O}_4$; sol. immediately in HF ; has not been fused; At. No. 22; At. Wt. 47.95; Mol. Wt. unknown; sp. gr. 4.5; val. 2, 3 and 4; M. P. 1800° ; B. P. $>3000^\circ$.

TiBr₃, *titanium bromide, titanium tribromide, titanous bromide*. Violet colored, deliq. cryst.; unstable.

TiBr₄, *titanium bromide, titanium tetrabromide, titanic bromide*. Fine, amber-yellow, dark yellow, or orange, cryst.; very hygroscopic; easily decomp. by water, yielding finally titanic acid; dil. mineral acids behave similarly; M. P. 39° ; B. P. 229° ; sp. gr. 2.6.

Titanium carbonate is unknown.

TiCl₂, *titanium chloride, titanium dichloride*. Black or brown powder; very deliq.; absorbs water rapidly; insol. in CS_2 and ether; decomp. much water with hissing and evolution of H_2 ; burns like tinder in air.

TiCl₃, *titanium chloride, titanium trichloride, titanium sesquichloride, titanous chloride*. Dark violet, very lustrous solid; deliq.; non-volatile; sol. in water to a violet liquid which decomp. to titanic acid; easily sol. in alcohol to a violet or green soln.; insol. in ether; forms TiO_2 when heated; powerful reducing agent; reduces H_2SO_3 to S, and HNO_3 and nitrates to NH_3 , and salts of Au, Ag, and Hg to their metals.

TeCl₄, *titanium chloride, titanium tetrachloride, titanic chloride*. Colorless liquid; solidifies at -30° ; non-conductor of electricity; fumes in air; absorbs moisture rapidly and solidifies to the hydrate; violently decomp. by water to titanic acid; B. P. 136° ; sp. gr. 1.7.

Ti(OH)₂, *titanium hydroxide, titanium dihydroxide, titanium hydrate*. Black ppt.

Ti(OH)₃, *titanium hydroxide, titanium trihydroxide, titanous hydroxide, titanium hydrate*. Brown ppt.

Ti(OH)₄, *titanium hydroxide, titanium tetrahydroxide, titanic hydroxide, titanium hydrate*; not known as *titanium hydroxide* but H_2TiO_4 , *titanic acid, orthotitanic acid*. White, gelatinous ppt.; insol. in water and alcohol; sol. in dil. acids, but less sol. after standing or being heated; forms salts called *titanates*; decomp. to TiO_2 by heat; when an HCl soln. of H_2TiO_4 is boiled **TiO(OH)₂**, *metatitanic acid* is formed.

Ti(NO₃)₃, *titanium nitrate*. The normal salt is unknown; a basic nitrate is known; sol. in water to a sl. milkiness; decomp. by boiling.

TiO, *titanium oxide, titanium monoxide*. Black, prismatic cryst.

Ti₂O₃, *titanium oxide, titanium sesquioxide, titanous oxide*. Black, or copper-red powder or lustrous, cryst. mass; changed to TiO_2 when heated in air; insol. in water, NH_4OH , HCl or HNO_3 ; difficultly sol. in H_2SO_4 ; sp. gr. 4.6.

TiO₂, *titanium oxide, titanium dioxide, titanic oxide, titanic anhydride, titanic acid anhydride*. Occurs native as rutile, anatase and brookite,—prismatic or octahedral cryst., with all shades of color; amorph. TiO_2 is a white tasteless powder that turns yellow then brown when heated; insol. in water, and in all acids except concd. H_2SO_4 ; fusible in oxy-hydrogen flame; resembles SiO_2 ; sol. in fused alkaline hydroxides or carbonates, forming titanates; insol. in liquid NH_3 ; sp. gr. of native forms varies from 3.8 to 4.3.

TiO₃, *titanium oxide, titanium trioxide, titanium peroxide*. The pptd. hydrated TiO_3 is a bright yellow ppt.; sol. in HCl with decomp.; sol. in H_2SO_4 .

Ti₂O₄, **Ti₃O₅**, and **Ti₄O₇** are said to exist.

Ti₂(SO₄)₃, *titanium sulfate, titanium sesquisulfate, titanous sulfate, normal titanous sulfate*. Green, cryst. powder; decomp. by heat; sol. in water; insol. in alcohol, ether and concd. H_2SO_4 ; cryst. with $8\text{H}_2\text{O}$ as a violet cryst.; sol. in water to a violet soln.; forms double sulfates, some of them alums.

Ti(SO₄)₂, *titanium sulfate, titanic sulfate, normal titanic sulfate*. White, translucent masses of doubtful existence; sol. in water, but soln. decomp. on boiling; cryst. with $3\text{H}_2\text{O}$ as yellow, transparent, deliq. amorph. masses; forms double salts; a basic titanic sulfate is known.

TiS, *titanium sulfide, titanium monosulfide*. Black powder, or dark red cryst.; resembles Bi; insol. in alkalis and dil. acids; sl. sol. in HNO_3 or aqua regia; insol. in HF.

Ti₂S₃, *titanium sulfide, titanium sesquisulfide*. Greenish black powder, or gray, metal-like solid; insol. in caustic alkali solns. and dil. acids; sol. in HF; sol. in HNO_3 and concd. H_2SO_4 to green solns.

TiS₂, *titanium sulfide, titanium disulfide, titanite sulfide*. Large, brassy yellow, lustrous, metal-like scales, resembling mosaic gold; forms TiO_2 and SO_2 when heated in air; decomp. slowly in moist air; oxidized to titanate acid by HNO_3 or aqua regia; sol. with difficulty in acids; decomp. by $\text{NaOH} + \text{Aq}$ and $\text{KOH} + \text{Aq}$; sol. in HF.

W, *tungsten, wolframium*. Hard, brittle, cryst. powder, varying in color from gray to brownish black, resembling sometimes Sn, sometimes Fe; fusible in oxy-hydrogen flame, part of it burning to WO_3 , more easily if the metal is powdered; attacked by Cl_2 at 250° , by F_2 at ordinary temp.; sol. in fused KOH , forming K tungstate; insol. in solns. of alkali hydroxides; attacked by fused peroxides, nitrates and alkali carbonates; sol. in a mixture of HNO_3 and HF; oxidized by aqua regia; the ductile form of W is even more ductile than Au; it has the lowest vapor pressure, and the highest M. P. of any metal; acted on slowly by molten S or P, but vigorously by their vapors; pure W is hard enough to scratch glass; when it contains C it is almost as hard as diamond; when added to steel it increases its hardness, toughness, elasticity, and tensile strength; W forms many salts; with the exception of the sulfides and the halogen salts, most of them contain W in the acid radical as WO_3 ; see under *tungstic acid*; insol. in water; sl. acted on by HCl , H_2SO_4 , or alkali solns.; HNO_3 oxidizes it to $\text{WO}_3 \cdot x\text{H}_2\text{O}$; At. No. 74; At. Wt. 184.0; Mol. Wt. unknown; sp. gr. 19.3; val. 2, 3, 4, 5 and 6; M. P. 3370° ; B. P. 5900° .

WB₂, *tungsten bromide, tungsten dibromide*. Bluish black, velvety, cryst. solid or powder; decomp. at high temp.; when treated with water part of it dissolves and the rest decomp.

WB₅, *tungsten bromide, tungsten pentabromide*. Dark, violet brown, needles with metallic luster; resembles I; M. P. 276° ; boils at 333° , giving off dark brown vapors; decomp. at high temp.; decomp. by moist air or by water, forming HBr and the blue oxide of W; sol. in HF, concd. HCl , alcohol and ether; decomp. by HNO_3 and H_2SO_4 .

WBr₆, *tungsten bromide, tungsten hexabromide*. Blue black needles; fumes in air; decomp. by water; decomp. when heated; sol. in NH_4OH .

Tungsten carbonate is unknown.

WCl₂, *tungsten chloride, tungsten dichloride*. Loose, gray, amorph. powder; non-volatile; decomp. by water to WO_3 and HCl .

WCl₃, *tungsten chloride, tungsten trichloride*. Not known, but double salts containing it are known.

WCl₄, *tungsten chloride, tungsten tetrachloride*. Soft, grayish brown, cryst. powder; decomp. by water or by heat; has not been fused or volatilized.

WCl₅, *tungsten chloride, tungsten pentachloride*. Long, black, lustrous needles, or dark green, cryst. powder; very deliq.; M. P. 248° ; B. P. 275° ; sl. sol. in CS_2 to a blue soln.; sol. in water to an olive green soln. which decomp., pptg. the blue oxide.

WCl₆, *tungsten chloride, tungsten hexachloride*. Dark violet cryst.; stable in dry air; sol. in CS_2 , from which it cryst. as hexagonal tablets; M. P. 275° ; B. P. 350° ; decomp. by hot water to WO_3 and HCl .

Two oxychlorides, WO_2Cl_2 and WOCl_4 , are known.

W(OH)₆, *tungsten hydroxide, tungsten hexahydroxide, tungsten hydrate*. Not known as such, but 2 partially dehydrated compounds are known, **H₂WO₆**, *tungstic acid*, and **H₂WO₅·H₂O**, *monohydrated tungstic acid*; the former is a yellow ppt., insol. in water and solns. of tungstates, but sol. in HF; the latter is a white, voluminous, amorph. ppt., sl. sol. in water and solns. of tungstates, and changed to H_2WO_4 by heat; salts of tungstic acid are called *tungstates*; they are insol. in water, except those of the alkali metals, and form perhaps the largest and most important class of W compounds; besides the salts of the 2 above acids, many other tungstates exist, analogous to the polychromates and polymolybdates, e. g., 1 molecule of an alkali oxide may combine with 1, 2, 3, 4, 5, 6, or 8 molecules of WO_3 ; furthermore, complex tungstates exist in which WO_3 combines with varying proportions of the oxides of B, Si, P, As, Sb, and V.

Tungsten nitrate is unknown.

NON-METALS AND RARE METALS

Tungsten Cont.

WO, *tungsten oxide, tungsten monoxide*. Insol. in water, KOH + Aq and all acids except HNO₃, which converts it into WO₃.

WO₃, *tungsten oxide, tungsten dioxide, brown oxide of tungsten*. Brown or red powder, with sl. violet reflection; when prepared in the dry way it is attacked only by aqua regia, which oxidizes it to WO₃; when moist it is sol. in HCl, H₂SO₄ and KOH + Aq, but insol. in NH₄OH; strongly pyrophoric; sp. gr. 12.

WO₃, *tungsten oxide, tungsten trioxide, tungstic anhydride, tungstic acid anhydride*. Heavy, canary-yellow powder, or wine-yellow, very lustrous, rhombic tablets, octahedra or prisms; becomes orange-yellow when heated; turns blue when heated with reducing agents; easily fusible before the blowpipe; not decomp. at 1750°; sometimes turns greenish in the light, owing to partial reduction; insol. in water or acids; sl. sol. in dil., easily in hot, concd. solns. of KOH, NaOH, Na₂CO₃, K₂CO₃ or NH₄OH.

W₂O₅, *tungsten oxide, tungsten pentoxide, blue oxide of tungsten*. Blue, amorph. powder of variable compn.; the formulas, W₂O₅ and W₁₀O₁₅, have also been given to it; probably it is WO₃.nWO₃, *tungsten tungstate*; sl. sol. in KOH + Aq; insol. in HNO₃ or aqua regia.

Other oxides are said to exist, but they are probably mixtures of the above oxides.

Tungsten sulfate is unknown.

WS₂, *tungsten sulfide, tungsten disulfide*. Soft, dark gray, lustrous, graphite-like, cryst. powder, or needle cryst.; insol. in water; burns in air forming WO₃; decomp. when heated out of air; insol. in HCl and H₂SO₄; oxidized by HNO₃; sp. gr. 7.5.

WS₃, *tungsten sulfide, tungsten trisulfide*. Black or chocolate brown powder; burns in air; sl. sol. in water, more on boiling with probable subsequent decomp.; sol. in alkaline sulfide solns., forming thio- salts; sol. in solns. of alkaline hydroxides and carbonates.

Uranium

U, *uranium*. Grayish black powder, or lustrous, hard, silver-white, metallic masses; somewhat malleable, but cannot be hammered into thin plates; melts near white heat; becomes covered on standing in air with a steel blue film of oxide; the powder burns at 150° to 170° in the air; takes a high polish; decomp. water slowly at ordinary temp., rapidly at 100°; burns in F₂ at ordinary temp., in Cl₂ at 180°, in Br₂ at 210°, in I₂ at 260°, in S vapor at 500°, and in N₂ at 1000°; amalgamates with Hg, but leaves pyrophoric U when the Hg is distilled off; alloys with a few metals; is radioactive; its solns. are fluorescent; addition of U to steel increases its hardness and tensile strength; uranous compounds containing tetravalent U are green and easily oxidized to higher forms; a series of compounds called *uranyl compounds* is known; these contain the bivalent radical, UO₂, in the place of the U itself; uranyl solns. are yellow in color and fluoresce greenish; insol. in water; slowly decomp. by cold, dil. H₂SO₄, rapidly on warming; easily sol. in dil. or concd. HCl; fused U is sl. sol. in concd. HNO₃ or H₂SO₄, but amorph. is easily sol.; insol. in HC₂H₃O₂, NH₄OH, NaOH + Aq or KOH + Aq; At. No. 92; At. Wt. 238.17; Mol. Wt. unknown; sp. gr. 18.7; val. 2, 3, 4, 5, 6 and 8; M. P. <1850°.

UBr₃, *uranium bromide, uranium tribromide*. Dark brown needles; volatilizes easily; very hygroscopic; sol. in water.

UBr₄, *uranium bromide, uranium tetrabromide, uranous bromide*. Black, or brown, lustrous, fusible leaflets; very deliq.; volatile at red heat; sol. in water with hissing sound to a green soln.; insol. in alcohol; sol. in ether; sp. gr. 4.8.

UO₂Br₂, *uranium oxybromide, uranyl bromide*. Yellow powder or needles; volatilizes easily; decomp. by heat; sol. in water and ether.

Uranium carbonate and uranyl carbonate are unknown; double uranyl carbonates with alkali metals are known.

UCl₃, *uranium chloride, uranium trichloride*. Brownish red solid; easily sol. in water to a red soln. which decomp., evolves H₂, and turns green.

UCl₄, *uranium chloride, uranium tetrachloride, uranous chloride*. Dark green, lustrous, octahedral cryst.; volatilizes to a red vapor at red heat; very deliq.; fumes in air; sol. in alcohol and acetone; insol. in ether; sol. in water with hissing sound to a green soln.

UCl₅, *uranium chloride, uranium pentachloride*. Long, dark needle cryst.; green metallic luster; ruby red by transmitted light; light brown powder; sol. in water to a yellowish green liquid; decomp. when heated.

UO₂Cl₂, *uranium chloride, uranium oxychloride, uranyl chloride*. Yellow, cryst. solid; fuses easily, but volatilizes only at high temp.; very deliq.; sol. in alcohol,

ether, concd. HCl, and concd. HNO_3 ; decomp. by H_2SO_4 ; sol. in water, 320 g. in 100 g. of water at 18° .

$\text{U}(\text{OH})_4$, or $\text{UO}_2 \cdot 2\text{H}_2\text{O}$, *uranium hydroxide, uranium tetrahydroxide, uranous hydroxide, hydrated uranium dioxide, uranium hydrate*. Voluminous, reddish brown ppt.; darkens on heating; oxidized by air and by alkali hydroxides to uranyl compounds; sol. in acids.

$\text{U}(\text{OH})_6$, *uranium hydroxide, uranium hexahydroxide, uranic hydroxide*; not known as such, but as $\text{UO}_3 \cdot \text{H}_2\text{O}$ or $\text{UO}_2 \cdot 2\text{H}_2\text{O}$, *dihydrated uranium trioxide*, which is a yellow solid, stable in air, decomp. by heat, sp. gr. 5.9, and reacting with alkalis to give *uranates* and with acids to give *uranyl compounds*; it is also known as $\text{UO}_3 \cdot \text{H}_2\text{O}$ or $\text{UO}_3 \cdot \text{H}_2\text{O}$ or $\text{UO}_2(\text{OH})_2$ or H_2UO_4 , *uranium metahydroxide, monohydrated uranium trioxide, uranyl hydroxide, uranic acid*, which is a yellow, or orange colored, amorph. solid, or rhombic cryst.; decomp. by heat; absorbs CO_2 from the air; insol. in water; sol. in acids; reacts with bases to form *uranates*, which are insol. in water, but sol. in acids; reacts with acids to form *uranyl salts* which are yellow, sol. in water, and fluorescent.

$\text{U}(\text{NO}_3)_4$, *uranium nitrate*. Not known.

$\text{UO}_2(\text{NO}_3) \cdot 6\text{H}_2\text{O}$, *uranyl nitrate, "uranium nitrate"*. Lemon yellow, rhombic cryst.; fluoresces green; the best known salt of U; cryst. with 1, 2, 3, 4, and 6 H_2O ; deliq.; decomp. to UO_3 at 250° ; M. P. 59° ; B. P. 118° ; sp. gr. 2.8; shows frictional luminosity and detonates when rubbed or crushed; sol. in water, 200 g. in 100 g. of cold water; forms double uranyl nitrates with alkali nitrates.

UO , *uranium oxide, uranium suboxide*. Of doubtful existence.

UO_2 , *uranium oxide, uranium dioxide, uranous oxide, black oxide of uranium*. Dark brown, pyrophoric powder; or copper-red, pyrophoric powder with metallic luster; or black, non-pyrophoric, octahedral cryst.; or microscopic, iron-gray needles; insol. in water, dil. HCl or H_2SO_4 ; sol. in concd. H_2SO_4 , and easily in HNO_3 ; oxidized to U_3O_8 when heated in air; only sl. sol. in acids after ignition; sp. gr. 10.5; sol. in acids to deep green solns. containing uranous salts.

UO_3 or $(\text{UO}_2)_2\text{O}$, *uranium oxide, uranium trioxide, uranic oxide, uranyl oxide*. Brick-red or chamois-yellow powder; decomp. to U_3O_8 and O_2 when heated in air; sl. volatile at very high temp.; reacts with water at ordinary temp., forming H_2UO_4 ; sol. in acids, forming uranyl salts; sol. in bases, forming uranates; see *uranic acid*; sp. gr. 5.9.

UO_4 , *uranium oxide, uranium tetroxide, uranium peroxide*. Not known as such; the tetrahydrated form, $\text{UO}_4 \cdot 4\text{H}_2\text{O}$, *peruranic hydroxide*, is a yellow or yellowish white ppt.; decomp. by heat and by HCl.

U_2O_5 , *uranium oxide, uranium pentoxide, black oxide of uranium*. Compn. is indefinite; sol. in acids.

U_3O_8 , or $\text{UO}_2 \cdot 2\text{UO}_3$, *uranium oxide, triuranium octoxide, urano-uranic oxide, uranoso-uranic oxide, green oxide of uranium, uranous uranate*. Dark, olive-green powder, sometimes almost black, but always showing a green streak when rubbed on unglazed porcelain; insol. in water; very slowly and sl. sol. in dil. HCl or H_2SO_4 , more easily when concd.; completely sol. in boiling H_2SO_4 ; easily sol. in HNO_3 ; only sl. sol. in mineral acids after ignition; sp. gr. 7.2; sol. in acids to greenish solns. containing uranyl salts.

$\text{U}(\text{SO}_4)_2$, *uranium sulfate, normal uranium sulfate, uranous sulfate*. The anhydrous sulfate is unknown; cryst. with $8\text{H}_2\text{O}$ as green, monoclinic cryst.; stable in air; when heated it loses its cryst. water, then decomp., first to $(\text{UO}_2)\text{SO}_4$, and finally to UO_3 ; sol. in water; easily sol. in dil. H_2SO_4 or HCl; decomp. by water to a basic salt; forms double sulfates with alkali sulfates.

UO_2SO_4 , *uranyl sulfate*. Citron yellow, or yellowish green, fluorescent, cryst.; decomp. by heat; sol. in water; forms double sulfates with alkali sulfates.

US , *uranium sulfide, uranium monosulfide*. Grayish black powder, sometimes amorph., sometimes cryst.

U_2S_3 , *uranium sulfide, uranium sesquisulfide*. Grayish black solid; decomp. in air; burns in air; sl. sol. in dil. HCl or HNO_3 ; violently decomp. by concd. H_2SO_4 ; oxidized by fuming H_2SO_4 or aqua regia.

US_2 , *uranium sulfide, uranium disulfide, uranous sulfide*. Black ppt., or dark, grayish black powder; oxidizes slowly in air, rapidly on heating; insol. in dil. HCl; easily sol. in cold, concd. HCl; decomp. by HNO_3 .

UO_2S , *uranyl sulfide*. Dark brown ppt., or black, tetragonal, needle cryst.; oxidizes easily in air; sl. sol. in water; easily sol. in acids and $(\text{NH}_4)_2\text{CO}_3 + \text{Aq}$; decomp. by caustic alkali solns.; sol. in dil., insol. in abs. alcohol.

UX_2 , *uranium X₂*. A radioactive element; said to be an isotope of protactinium or of thorium; occupies the vacant place in the Periodic Table assigned

Uranium
X₂

NON-METALS AND RARE METALS

Uranium

X₂

Cont.

to ekatantalum; has the same properties as ekatantalum, but a different At. Wt.; only minute quantities occur in uranium preparations; has not been isolated; At. No. 91; At. Wt. 234.

No compounds of uranium X₂ are known.

Vanadium

V, *vanadium*. Light gray, lustrous powder; the microscope shows it to be composed of silver-white, cryst. particles; does not become coherent when compressed; not magnetic; not oxidized in air at ordinary temp.; powder burns in Bunsen flame; takes a good polish which is permanent; unaffected by moisture or water; non-volatile; reacts with fused NaOH, forming H₂ and Na vanadate; unites directly with N₂ and Cl₂; alloys with Pt, Fe, Al and Cu; harder than steel; added to steel it helps remove the oxide and nitride impurities, and increases the resistance to vibration and strain; V compounds are numerous and some are complex; its 5 oxides represent 5 states of oxidation of which 4 have representative salts; val. 1, 2, 3, 4, and 5; the nomenclature of the V compounds is much confused because a different system of naming is found in the older literature; hence the apparent double naming of the compounds described below; solid, when heated in air, is oxidized, forming various oxides with their characteristic colors.—V₂O(brown), V₂O₃(gray), V₂O₃(black), V₂O₄(blue) and finally V₂O₅(red); insol. in water, HCl, dil. H₂SO₄ and cold concd. H₂SO₄; sol. in hot, concd. H₂SO₄; slowly sol. in HF; easily sol. in dil. or concd. HNO₃; insol. in NaOH + Aq and KOH + Aq; At. No. 23; At. Wt. 50.96; Mol. Wt. unknown; sp. gr. 5.96; M. P. 1710°; B. P. (3000°); 1 isotope.

VBr₃, *vanadium bromide, vanadium tribromide, vanadic bromide* (formerly called *vanadous bromide* or *vanadious bromide*). Grayish black, opaque, amorph. solid; very deliq.; decomp. by heat; sol. in water to a brown soln.; sol. in ether and alcohol.

VOBr₃, *vanadium bromide, vanadium oxybromide, vanadyl bromide*. Dark red, transparent, liquid or solid; decomp. by moisture and by heat; sp. gr. 2.9.

Vanadium carbonate is unknown.

VCl₂, *vanadium chloride, vanadium dichloride, vanadous chloride, vanadious chloride* (formerly called *hypovanadous chloride* or *hypovanadious chloride*). Apple green, hexagonal scales; micaceous luster; very deliq.; sol. in water to a violet soln.; sol. in alcohol and ether; sp. gr. 3.2.

VCl₃, *vanadium chloride, vanadium trichloride, vanadic chloride* (formerly called *vanadous chloride* or *vanadious chloride*). Lustrous, peach-blossom colored tablets; resembles CrCl₃; very deliq. to a brown soln.; sol. in water, ether and alcohol; decomp. by heat; sp. gr. 3.

VCl₄, *vanadium chloride, vanadium tetrachloride* (formerly called *hypovanadic chloride*). Thick liquid; dark reddish brown; decomp. to VCl₃ at ordinary temp., more rapidly in sunlight or when heated; fumes white in air; sol. in water to a blue soln.; reacts violently with ether and alcohol; M. P. —109°; B. P. 154°; sp. gr. 1.8.

V₂O₂Cl₂, *vanadium oxychloride, divanadyl monochloride*. Yellow cryst. powder; insol. in water; sol. in HNO₃.

VOCl₂, *vanadium oxychloride, vanadyl monochloride*. Brown powder; insol. in water; sol. in HNO₃; sp. gr. 2.8.

VOCl₃, *vanadium oxychloride, vanadyl dichloride*. Green, deliq. tablets; decomp. by water; easily sol. in HNO₃; sp. gr. 2.8.

VOCl₄, *vanadium oxychloride, vanadyl trichloride*. Bright, lemon yellow, mobile liquid; B. P. 126°; M. P. —15°; sp. gr. 1.8.

V(OH)₂, *vanadium hydroxide, vanadium dihydroxide, vanadous hydroxide, vanadious hydroxide, vanadium hydrate*. Not known as such, but as VO_xH₂O; sol. in HCl; insol. in NaOH + Aq and KOH + Aq.

V(OH)₃, *vanadium hydroxide, vanadium trihydroxide, vanadic hydroxide, vanadium hydrate* (formerly called *vanadous hydroxide* or *vanadious hydroxide*). Not known as such, but as V₂O₃·xH₂O; greenish, gelatinous ppt.; oxidizes easily in air; easily sol. in acids.

V(OH)₄, *vanadium hydroxide, vanadium tetrahydroxide, vanadium hydrate* (formerly called *hypovanadic hydroxide*). Not known as such, but as V₂O₄(OH)₂·5H₂O; a gray ppt. which darkens when drying; easily sol. in acids or alkalis; forms salts called *vanadites* (formerly called *hypovanadates*).

V(OH)₅, *vanadium hydroxide, vanadium pentahydroxide, vanadium hydrate*. Not known as such, but as H₅VO₅, or better, known in the 3 forms: (1) H₄V₂O₇, *pyrovanadic acid*, the salts of which called *pyrovanadates*, and are not common, or (2) HVO₃, *metavanadic acid*, which is an unstable brown ppt., resembling Fe(OH)₃, and forms salts called *metavanadates*, all insol. in water

except those of the alkali metals, or (3) H_3VO_4 , *orthovanadic acid*, which is unknown; its salts called *orthovanadates* are known, all insol. in water except those of the alkali metals.

$\text{V}(\text{OH})_5$, *vanadium hydroxide, vanadium hepthydroxide, vanadium hydrate*. Not known as such, but as HVO_4 , *pervanadic acid*, which occurs as yellow cryst. and from which are formed salts called *pervanadates*, solns. of which are deep orange yellow in color.

Vanadium nitrates are of indefinite compn. and of doubtful existence.

V_2O , *vanadium oxide, vanadium monoxide, hypovanadous oxide, hypovanadous oxide*. Brown powder.

VO or V_2O_3 , *vanadium oxide, vanadium dioxide, vanadous oxide, vanadious oxide* (formerly called *hypovanadous oxide* or *hypovanadious oxide*). Light gray, lustrous powder; or lustrous, metal-like, cryst. crust; very brittle; fuses at high temp., changing slowly to V_2O_5 ; insol. in water; easily sol. in dil. acids, giving lavender solns. which bleach strongly; sp. gr. 5.7.

V_2O_5 , *vanadium oxide, vanadium trioxide, vanadic oxide* (formerly called *vanadous oxide* or *vanadious oxide*). Black, graphite-like powder, or black, lustrous cryst.; infusible; changes to V_2O_3 when heated; oxidized by water and dissolves; easily sol. in HF; sol. in HNO_3 ; insol. in HCl , H_2SO_4 and alkali solns.; M. P. 1970° ; sp. gr. 4.9.

VO_2 or V_2O_4 , *vanadium oxide, vanadium tetroxide* (formerly called *hypovanadic oxide*). Blue, lustrous, cryst. powder, sometimes dark green and amorph.; infusible; insol. in water; easily sol. in acids, forming bright blue solns.; easily sol. in alkali solns.; M. P. 1755° ; sp. gr. 4.4.

V_2O_5 , *vanadium oxide, vanadium pentoxide, vanadic anhydride, vanadic acid anhydride*. Pale-yellow powder with reddish tinge, or yellowish red, cryst. needles, ruby red by transmitted light; odorless and tasteless; reddens moist litmus paper; nearly insol. in water; sol. in acids and alkali hydrate and carbonate solns.; insol. in alcohol and glacial $\text{HC}_2\text{H}_3\text{O}_2$; M. P. 800° ; sp. gr. 3.4.

V_2O_6 , *vanadium oxide, vanadium heptoxide, vanadium peroxide*. Unknown; see vanadium hepthydroxide.

$\text{VSO}_4 \cdot 7\text{H}_2\text{O}$, *vanadium sulfate, vanadous sulfate, vanadious sulfate* (formerly called *hypovanadous sulfate, hypovanadious sulfate*). Violet cryst.; sol. in water; forms double sulfates.

$\text{V}_2(\text{SO}_4)_3$, *vanadium sulfate, vanadium sesquisulfate, vanadic sulfate, normal vanadic sulfate* (formerly called *normal vanadous sulfate, normal vanadious sulfate*). Fine, yellow, cryst. powder; insol. in water and concd. H_2SO_4 , alcohol and ether; good reducing agent; forms alums with alkali sulfates.

$\text{V}_4(\text{SO}_4)_3 \cdot \text{H}_2\text{SO}_4 \cdot 12\text{H}_2\text{O}$, *vanadium sulfate, vanadic acid sulfate, vanadic hydrogen sulfate*. Minute, green cryst.; sol. in water and HCl ; insol. in alcohol and ether.

$\text{V}(\text{SO}_4)_2$, *vanadium sulfate*. Unknown.

VOSO_4 or $(\text{VO})_2(\text{SO}_4)_2$, *vanadium sulfate, basic vanadium sulfate, "vanadyl sulfate," "divanadyl sulfate"*. Blue ppt. or powder; insol. in water, HCl and dil. H_2SO_4 .

$(\text{VO})_2(\text{SO}_4)_3$, *vanadium sulfate, "divanadyl trisulfate"*. Reddish scales or ruby red octahedra; very deliq.; insol. in water, HCl and dil. H_2SO_4 .

VS or V_2S_3 , *vanadium sulfide, vanadium monosulfide, vanadous sulfide, vanadious sulfide* (formerly called *hypovanadous sulfide, hypovanadious sulfide*). Black, lustrous plates or brownish black powder; oxidizes when heated; insol. in water; insol. in boiling dil. or concd. HCl , dil. H_2SO_4 , or cold concd. H_2SO_4 ; easily sol. in hot dil. or concd. HNO_3 , or in boiling concd. H_2SO_4 ; insol. in $\text{NaOH} + \text{Aq}$ or $\text{KOH} + \text{Aq}$; sp. gr. 4.2.

V_2S_5 , *vanadium sulfide, vanadium trisulfide, vanadium sesquisulfide, vanadic sulfide* (formerly called *vanadous sulfide* or *vanadious sulfide*). Dark, lustrous plates, or black or greenish black, amorph. powder; the most stable of the sulfides; oxidizes when heated; insol. in water; insol. in cold HCl or dil. H_2SO_4 ; very sl. sol. in hot HCl or dil. H_2SO_4 ; more sol. in HNO_3 or concd. H_2SO_4 ; sl. sol. in $\text{NaOH} + \text{Aq}$ or NH_4OH ; sp. gr. 4.7.

V_2S_5 , *vanadium sulfide, vanadium pentasulfide* (formerly called *vanadic sulfide*). Black powder; oxidizes when heated; insol. in water; sl. sol. in hot concd. HCl or hot dil. H_2SO_4 ; sol. in hot concd. H_2SO_4 ; sol. in hot dil. HNO_3 ; easily sol. in $\text{NaOH} + \text{Aq}$; sl. sol. in NH_4OH ; sp. gr. 3.

Xe, xenon. One of the least volatile and least abundant of the rare gases in the air; very inert; sp. gr. liquid 3, solid 2.7; M. P. -140° ; B. P. -109.1° ;

Xenon

NON-METALS AND RARE METALS

Xenon Cont.

solid Xe volatilizes without melting; critical temp. 14.8° ; critical pressure 57 atmospheres; At. No. 54; At. Wt. 130.2; val. 0; 7 or 9 isotopes.
No compounds of xenon are known.

Ytterbium

Yb, *ytterbium*, sometimes called *neo-ytterbium*. Apparently has not been isolated yet; solns. of its salts are colorless; At. No. 70; At. Wt. 173.6; val. 3.
YbBr₃, *ytterbium bromide*. Cryst. with $8\text{H}_2\text{O}$; more deliq. than YbCl_3 ; sol. in water.

Yb₂(CO₃)₃·4H₂O, *ytterbium carbonate*. Gelatinous ppt.; sp. gr. 3.8.

YbCl₃, *ytterbium chloride*. Cryst. with $6\text{H}_2\text{O}$; deliq.; easily sol. in water; decomp. to oxychloride by heat; sol. in alcohol; M. P. 150° ; sp. gr. 2.6.

Yb(OH)₃, *ytterbium hydroxide*, *ytterbium hydrate*. Gelatinous ppt.; absorbs CO₂ from the air.

Yb(NO₃)₃·4H₂O, *ytterbium nitrate*. Prismatic cryst.; deliq.; easily sol. in water; sp. gr. 2.7.

Yb₂O₃, *ytterbium oxide*, *ytterbia*. Heavy, white, infusible powder; slowly sol. in cold acids, easily and rapidly sol. at 100° to colorless solns.; sp. gr. 9.2.

Yb₂(SO₄)₃, *ytterbium sulfate*. White, opaque solid; cryst. with $8\text{H}_2\text{O}$; sol. in water; decomp. by heat; sp. gr. 3.8.

Yb₂S₃, *ytterbium sulfide*. Unknown.

Yttrium

Y or **Yt**, *yttrium*. Grayish-black powder; metallic luster; iron gray at first, but turns dark in the light; solns. of its salts are colorless; decomp. water sl. at ordinary temp., rapidly on boiling, forming the oxide; oxidizes when heated in air or O₂; easily sol. in dil. acids, even $\text{HC}_2\text{H}_3\text{O}_2$; sl. sol. in concd. H_2SO_4 ; decomp. hot KOH + Aq; val. 3; At. No. 39; At. Wt. 89.0; M. P. 1490° ; B. P. (2500°) ; sp. gr. 5.51; 1 isotope.

YBr₃ or **YtBr₃**, *yttrium bromide*. Cryst. with $9\text{H}_2\text{O}$ as colorless tablets; very deliq.; sol. in water and alcohol; insol. in ether; easily fusible.

Y₂(CO₃)₃ or **Yt₂(CO₃)₃**, *yttrium carbonate*. Heavy, white ppt.; not easily decomp. by heat; sl. sol. in CO₂ + Aq; sol. in Na_2CO_3 + Aq and $(\text{NH}_4)_2\text{CO}_3$ + Aq.

YCl₃ or **YtCl₃**, *yttrium chloride*. Cryst. with $6\text{H}_2\text{O}$ as large, colorless, rhombic prisms; very deliq.; sol. in water and alcohol; insol. in ether; decomp. by heat; M. P. $< 636^{\circ}$; sp. gr. 2.8.

Y(OH)₃ or **Yt(OH)₃**, *yttrium hydroxide*, *yttrium hydrate*. White, gelatinous ppt.; probably hydrated; resembles Al(OH)_3 ; insol. in NaOH + Aq and NH_4OH ; absorbs CO₂ from the air.

Y(NO₃)₃ or **Yt(NO₃)₃**, *yttrium nitrate*. Cryst. with $6\text{H}_2\text{O}$ as large, translucent cryst.; forms a basic salt when heated.

Y₂O₃, *yttrium oxide*, *yttria*. Heavy, white powder; insol. in water; sl. sol. in cold acids, more in hot; sol. in $\text{HC}_2\text{H}_3\text{O}_2$; insol. in NH_4OH and KOH + Aq; M. P. 2410° ; sp. gr. 4.8.

Y₂O₆, *yttrium oxide*, *yttrium peroxide*. Known.

Y₂(SO₄)₃ or **Yt₂(SO₄)₃**, *yttrium sulfate*. Cryst. with $8\text{H}_2\text{O}$ as small, transparent, colorless cryst.; heat drives off the cryst. water at 115° and forms a basic salt at 700° ; sol. in water, 15 g. in 100 g. of water at ordinary temp.; less sol. in hot water; sp. gr. 2.6.

Y₂S₃ or **Yt₂S₃**, *yttrium sulfide*. Yellow or gray powder; insol. in water; decomp. by acids.

Zirconium

Zr, *zirconium*. Occurs in two forms,—amorph. and cryst. *Amorph. Zr* is a black, porous, charcoal-like powder that may be compressed to graphite-like laminae; burns to ZrO₂ in air with white light; easily sol. in HF; slowly sol. in boiling aqua regia, H_2SO_4 or concd. HCl. *Cryst. Zr* is a grayish, brittle, very hard and lustrous solid, resembling Sb; oxidizes at white heat; unites with Cl₂ and Br₂; unites with S; sol. in KOH + Aq, evolving H₂; oxidized rapidly by aqua regia; oxidized by fused carbonates, nitrates and chlorates; takes a high polish; hard to get pure; the pure form is probably like the amorph. Zr described above; alloys with Fe, Ni, Co, Mg, Ag, and some other metals; sol. in cold, concd. HF; violently sol. in a mixture of HNO₃ and HF; slowly sol. in hot, concd. HCl; At. No. 40; At. Wt. 91; Mol. Wt. unknown; val. 2, 3, 4, and 5, but usually 4; sp. gr. 6.4; M. P. 1700° ; B. P. $(>2900^{\circ})$; 3 isotopes.

ZrBr₄, *zirconium bromide*. Very small, white cryst.; hygroscopic; volatilizes easily; forms the oxybromide in moist air or water; cryst. with $7\text{H}_2\text{O}$ as large, transparent cryst.; sol. in organic solvents.

Zr(CO₃)₂, *zirconium carbonate*. A ppt. of variable compn.; probably a basic carbonate; sol. in solns. of alkaline carbonates; decomp. by hot water.

ZrCl₄, *zirconium chloride*. White, cryst. solid; resembles non-metallic chlorides; volatilizes at c. 400°; sol. in water with production of heat, giving oxychlorides; hydrolyzes easily.

Zr(OH)₄, *zirconium hydroxide, zirconium hydrate*. White, voluminous, gelatinous ppt.; insol. in water, or only sl. sol. therein; insol. in alcohol; easily sol. in acids when pptd. cold; when pptd. hot it is sol. only in concd. acids; behaves as a weak acid towards bases, and with alkali and alkaline earth metals forms salts called *zirconates*; decomp. when heated, first to **Zr₂H₂O**, *zirconic acid*, and finally to **ZrO₂**; insol. in alkaline hydroxide solns. and solns. of **NH₄** salts.

Zr(NO₃)₄, *zirconium nitrate*. Yellow, gummy masses; sol. in water; decomp. to insol. basic nitrates by heat.

ZrO, *zirconium oxide, zirconium suboxide*. Of doubtful existence.

ZrO₂, *zirconium oxide, zirconium dioxide, zirconia*. White, tasteless, odorless, amorph. powder, or transparent, colorless, hard, prismatic cryst.; when ignited, is insol. in all acids except HF and **H₂SO₄**; sl. sol. in HF and sol. in **H₂SO₄** only when finely powdered; practically infusible; incandescs when heated; forms *zirconates* when fused with **NaOH** or **KOH**; sp. gr. 5.7.

Zr₂O₃, *zirconium oxide, zirconium sesquioxide*. Said to exist.

ZrO₃ and **Zr₂O₅**, *zirconium oxide, zirconium peroxide*. Insol. in water and cold, dil. **H₂SO₄**.

Zr(SO₄)₂, *zirconium sulfate, normal zirconium sulfate*. White, amorph. masses; sol. in water, slowly cold, rapidly hot; sol. in **H₂SO₄**; insol. in alcohol; decomp. to **ZrO₂** by heat; cryst. with 4**H₂O** as colorless cryst.; an insol. basic salt called *zirconyl sulfate* is known; an acid salt is also known.

ZrS₂, *zirconium sulfide*. Dark brown powder, or steel gray cryst. with metallic luster; insol. in water and dil. acids; sl. sol. in aqua regia; sol. in HF; insol. in **KOH** + **Aq**; decomp. by fused **KOH**; oxidized by **HNO₃**, pptg. **S**.

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